Strategies for Flood Risk Reduction for Vulnerable Coastal Populations around Barnegat Bay

FINAL REPORT

Submitted to

New Jersey Governor's Office of Recovery and Rebuilding
and
New Jersey Department of Environmental Protection

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EXECUTIVE SUMMARY

Most residences along Barnegat Bay are located at low-lying areas. During Superstorm Sandy, communities along Barnegat Bay were seriously impacted. To protect the populations and properties along Barnegat Bay, a list of flood defense measures are proposed in this study. For each specific field conditions, in terms of topographic analysis and flood data, the selection and placement of various alternatives are portrayed on maps and listed in relevant tables, including the various quantities (e.g., lengths and water depths, as well as other variables). The water protection levels used for the placement of coastal flood defense measures include 10-year, 50-year, and 100-year recurrence interval coastal floods, plus predicted rising sea levels. For the stormwater drainage-related flood defense, 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year rainfall events are used for the determinations of pump station capacities and unit numbers.

A completed model (including bulkhead/floodwall, sluice gate or in-water barrier, flood gate, bulkhead/floodwall closer, flap gate/check valve, pump station, etc.) for Toms River Township, Lavallette Borough, and Seaside Heights Borough are provided in this study. It can be used as a typical model.

Most of the locations along Barnegat Bay have had bulkheads installed in the past. The existing bulkheads are too low to prevent the flood levels predicted in the future. Increasing the bulkhead height with or without movable panels, that may be time and cost effective, are proposed in this study. In response to the social, environmental, and financial concerns, two new types of movable flood walls were developed. They can be used to increase the bulkhead heights.

If the budget is limited, it is recommended that the construction processes can be divided into two or three phases. Phase I is designed to build the permanent structure (set at 3 to 4 ft heights**,** i.e. 10-year flood level) on the top of the existing bulkheads, and to keep the adaptors for a later installation of the movable panels in Phase II or Phase III. Detailed illustrations of the options for construction are presented in the report.

During extreme weather events, such as Superstorm Sandy, the power supply systems may be seriously damaged, and the conventional pumping stations may not work. Therefore, to solve this problem, six new types of pumps driven by green energies are conceptually designed and incorporated in this study.

The green pumps can also be utilized during frequent rainfall events to facilitate the stormwater drainage and reduce the level of flooding. The option of deploying stormwater green infrastructure to reduce the runoff produced by rainfall is explored as well.

This study focuses on some possible engineering solutions options. Some other options as well as the environmental impacts of the proposed options are evaluated elsewhere.

I INTRODUCTION

1.1 Background

Coastal flooding can result from a variety of different sources such as storm surges caused by hurricanes and cyclones, by rising sea levels due to climate change, as well as by tsunamis. In late October 2012, Superstorm Sandy made landfill near Atlantic City, New Jersey. Communities along coastal New Jersey and coastal New York were seriously impacted. During Superstorm Sandy, the measured water level at its highpoint within Barnegat Bay at the Route 37 Bridge near the bayshore was about 6.5 ft, almost 5 ft above the spring high tide (Fig. 1.1). The situation would have been even worse if the storm had also been accompanied by heavy rainfall.

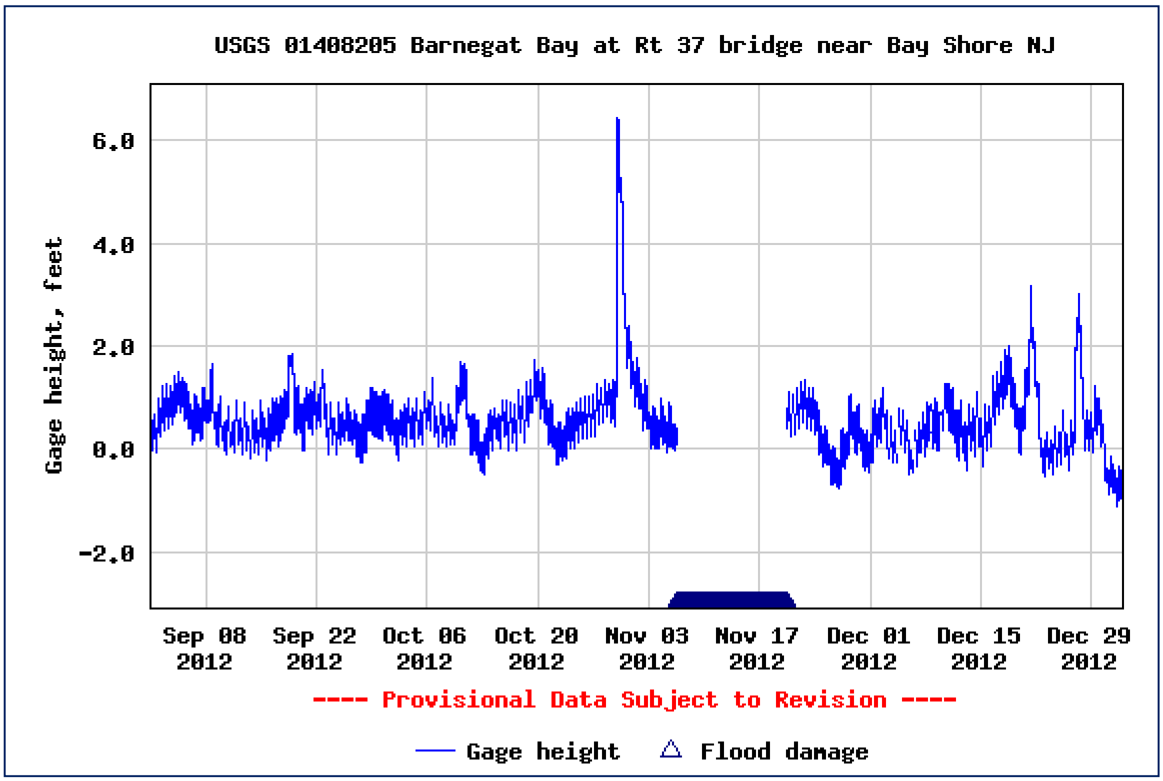


Fig. 1.1 Recorded Water Levels within Barnegat Bay at the Route 37 Bridge near the Bayshore during Superstorm Sandy (Source: USGS 01408205 Barnegat Bay at Rt 37 Bridge near Bay Shore NJ: http://waterdata.usgs.gov/nj/nwis/uv/?site_no=01408205).

Superstorm Sandy caused unprecedented damage to New Jersey's housing, infrastructure, business, health, social service, and environmental sectors. Ocean County is one of the most impacted areas. During Superstorm Sandy, many municipalities were severely inundated after the storm entered into the bay, resulting in thousands of homeless and millions without power (Figs. 1.2 and 1.3).

Fig. 1.2 Superstorm Sandy Flooding on the Bayside of Seaside Heights, New Jersey (Governor's Office/Tim Larsen).

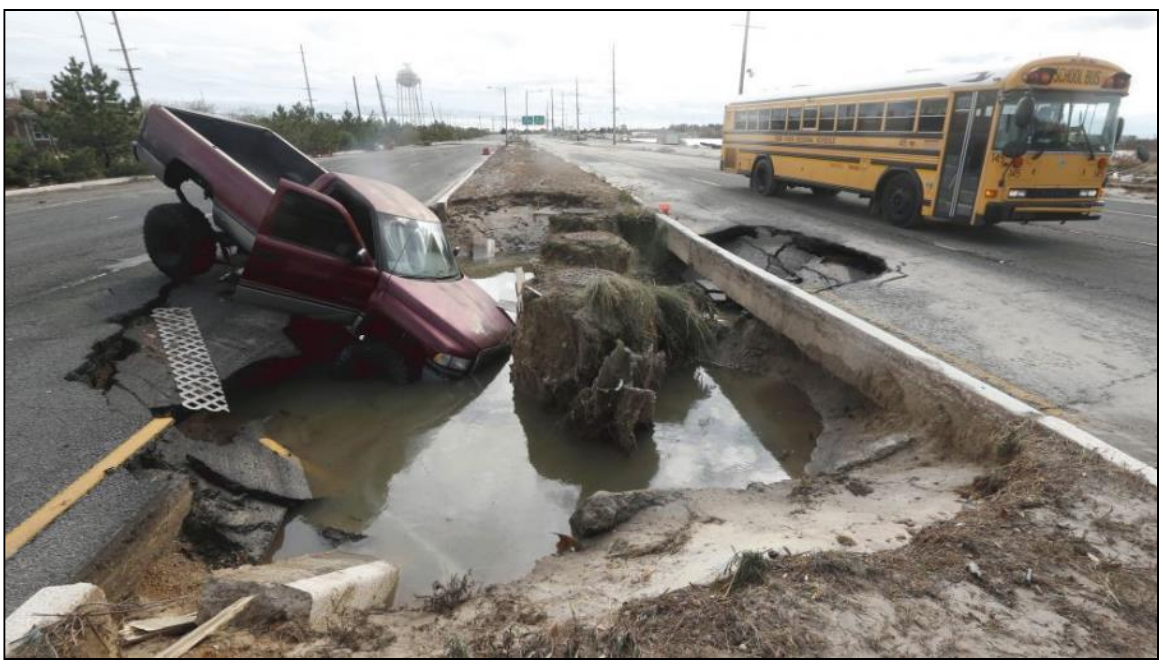


Fig. 1.3 Superstorm Sandy Damage to the Infrastructure, Seaside Heights, New Jersey (AP Photo/Julio Cortez)

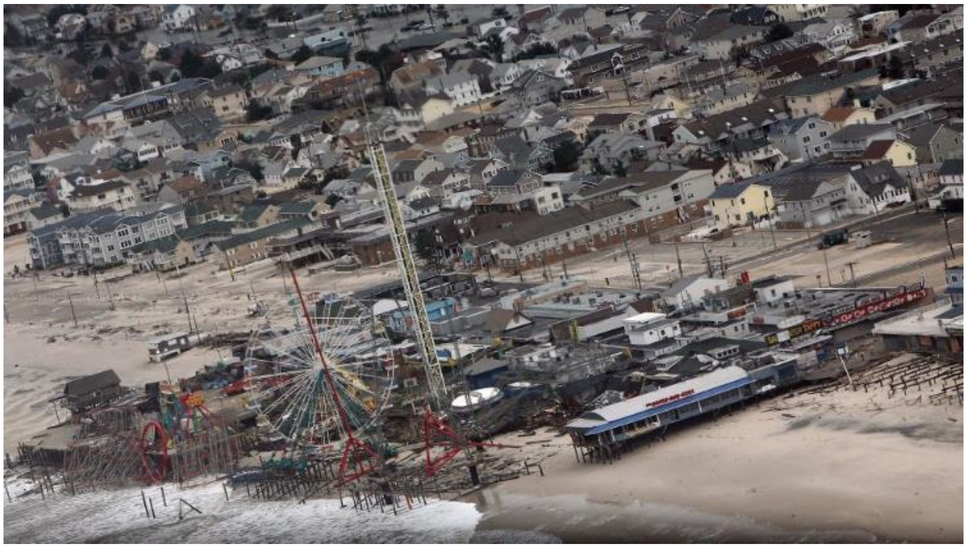


Fig. 1.4 Superstorm Sandy Damage to Boardwalk, Seaside Heights, New Jersey (Governor's Office/Tim Larsen)

The communities around Barnegat Bay are at risk from flooding due to their location and physical setting. Flooding in back-bay areas may be a result of intense precipitation, runoff, and high winds (e.g., Hurricane Irene in 2011), or it may be caused by tides and/or storm surges (e.g., Superstorm Sandy in 2012), or a combination of the two.

In an effort to create an improved capability to protect against future events that may cause severe flooding along the margin of Barnegat Bay and impact a wide variety of individual and municipal facilities, there is a need to critically review the existing conditions relative to their level of resistance to the dangers of flooding, to evaluate their performance in response to Superstorm Sandy, and to propose options to improving the flood protection measures through a variety of engineering and land-use management strategies.

1.2 Study Area and Existing Problems Description

Based on an examination of the flood potential and geographical location of townships and boroughs, the selected study areas are integrated into five parts. Each part includes one to three townships/ boroughs. They are organized as follows:

1) **Point Pleasant Borough** (including Point Pleasant Beach Borough, and Bay Head Borough)
2) **Brick Township** (including Mantoloking Borough)
3) **Toms River Township and Seaside Heights Borough** (including Lavallette Borough)
4) **Stafford Township**
5) **Little Egg Harbor Township** (including Tuckerton Borough)

The following provides a brief description of study areas and existing problems.

1.2.1 Point Pleasant Borough (including Point Pleasant Beach Borough, and Bay Head Borough**)**

Fig. 1.5.1 shows the land cover/land use information and waterway systems at Point Pleasant Borough, Point Pleasant Beach Borough, and Bay Head Borough in New Jersey. Land use in the three boroughs of Point Pleasant, Point Pleasant Beach, and Bay Head is largely in urban development (Fig. 1.5.1).

Fig. 1.5.1 Land Use/Land Cover Background at Point Pleasant Borough, Point Pleasant Beach Borough, and Bay Head Borough, New Jersey.

Existing Problems:

Fig. 1.5.2 shows the Superstorm Sandy flood prone area. The existing problems are as follows:

- Residents along the Manasquan River and most of the eastern portion of the communities are located in low-lying terrain. The residents in those locations were severely flooded by Superstorm Sandy. The existing bulkheads were too low to provide a defense against the storm surge of Superstorm Sandy, further there is no storm surge barrier at the end of the Cooks Creek.

- The south area along Bay Head Harbor and the location near North Branch Beaverdam Creek are located at low-lying areas. The residents along the dredged lagoons were totally flooded by Superstorm Sandy. The bulkheads were too low to provide a defense against the storm surge. In addition, there are no storm surge barriers at the ends of the dredged lagoons.

- Bay Head Borough is located in a low-lying area. The existing bulkheads along Point Pleasant Canal and Bay Head Harbor were too low to resist the storm surge. Almost all the properties in the borough were inundated by Superstorm Sandy.

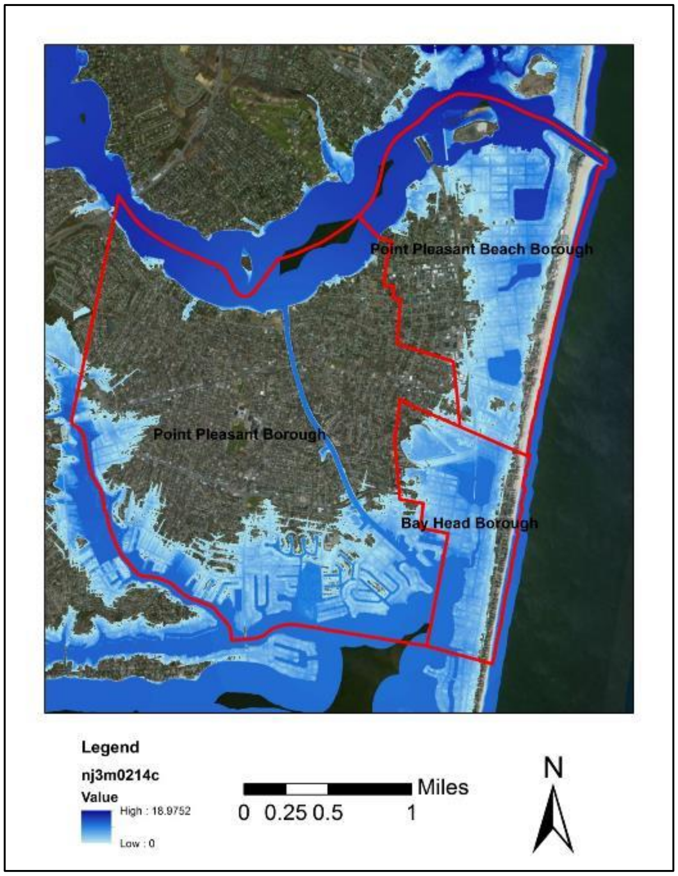


Fig.1.5.2 Superstorm Sandy Flooded Area in Point Pleasant Borough, Point Pleasant Beach Borough, and Bay Head Borough, New Jersey.
(Source: FEMA Modeling Task Force: http://184.72.33.183/GISData/MOTF/Hurricane%20Sandy/)

1.2.2 Brick Township (including Mantoloking Borough)

Fig. 1.6.1 shows the land cover/land use information and waterway systems at Brick Township and Mantoloking Borough, New Jersey. The red color represents the urban areas. Land use in Brick Township and Mantoloking Borough is largely in urban development.

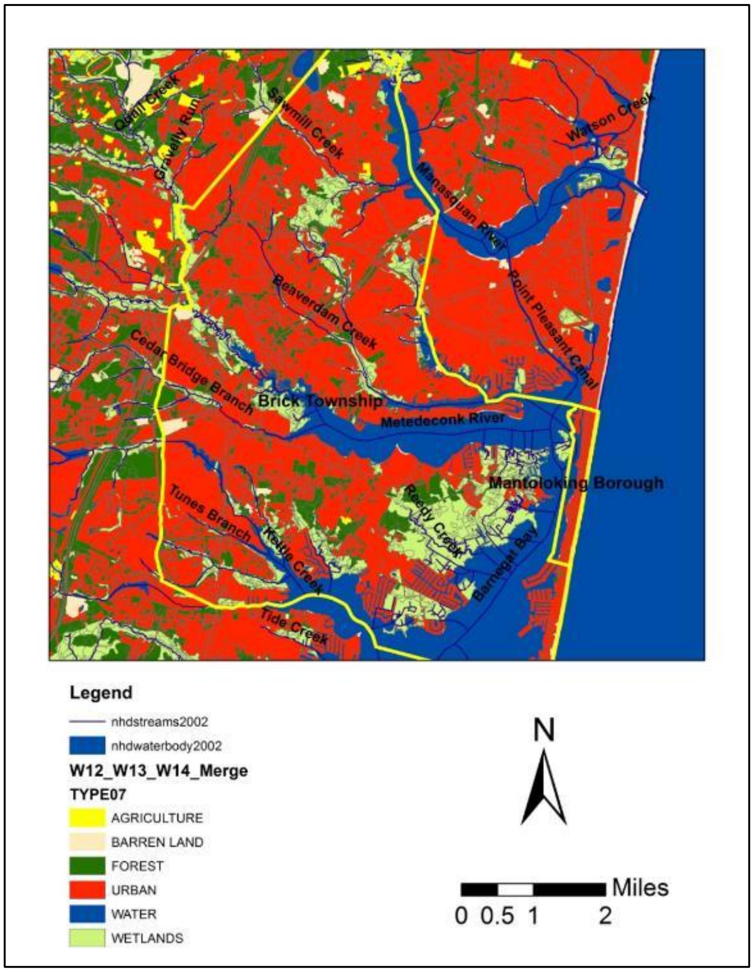


Fig. 1.6.1 Land Use/Land Cover and Waterway Systems in Brick Township and Mantoloking Borough, New Jersey.

Existing Problems:

A large proportion of Brick Township and Mantoloking Borough were flooded during Superstorm Sandy (Fig. 1.6.2). The existing problems are as follows:

- For Brick Township, the existing bulkheads along the Manasquan River and Metedeconk River were too low to resist the storm surge. The residents in the southern section are located in a low-lying area, and the existing bulkheads along the dredged lagoons are too low to block the storm surge. There are also no surge barriers at the ends of the dredged lagoons.

- Mantoloking Borough is located at a low-lying area along the northern margin of the Barnegat Bay. The existing bulkheads along the bayshore were too low to resist the storm surge, and there are no surge barriers at the ends of the dredged lagoons. Almost all residential properties in the borough were flooded by Superstorm Sandy.

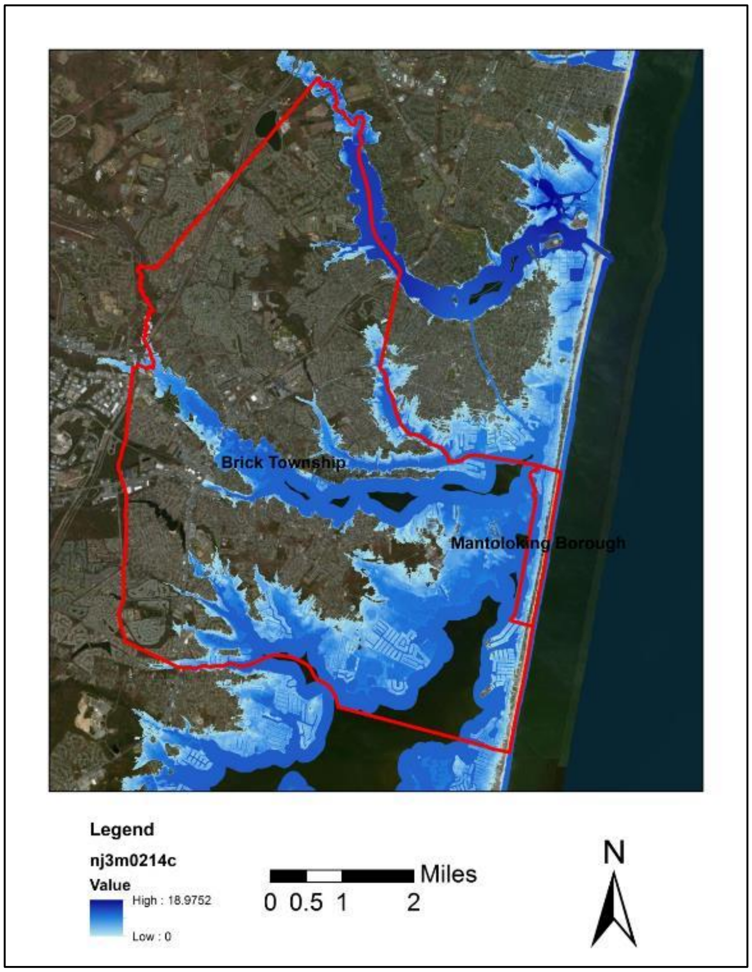


Fig. 1.6.2 Superstorm Sandy Flooded Area in Brick Township, and Mantoloking Borough, New Jersey.
(Source: FEMA Modeling Task Force: http://184.72.33.183/GISData/MOTF/Hurricane%20Sandy/)

1.2.3 Toms River Township and Seaside Heights Borough (including Lavallette Borough)

Fig. 1.7.1 shows the land cover/land use information and waterway systems for Toms River Township, Lavallette Borough, and Seaside Heights Borough, N.J. The red color represents the urban areas. Land use in these three municipalities is largely in urban development.

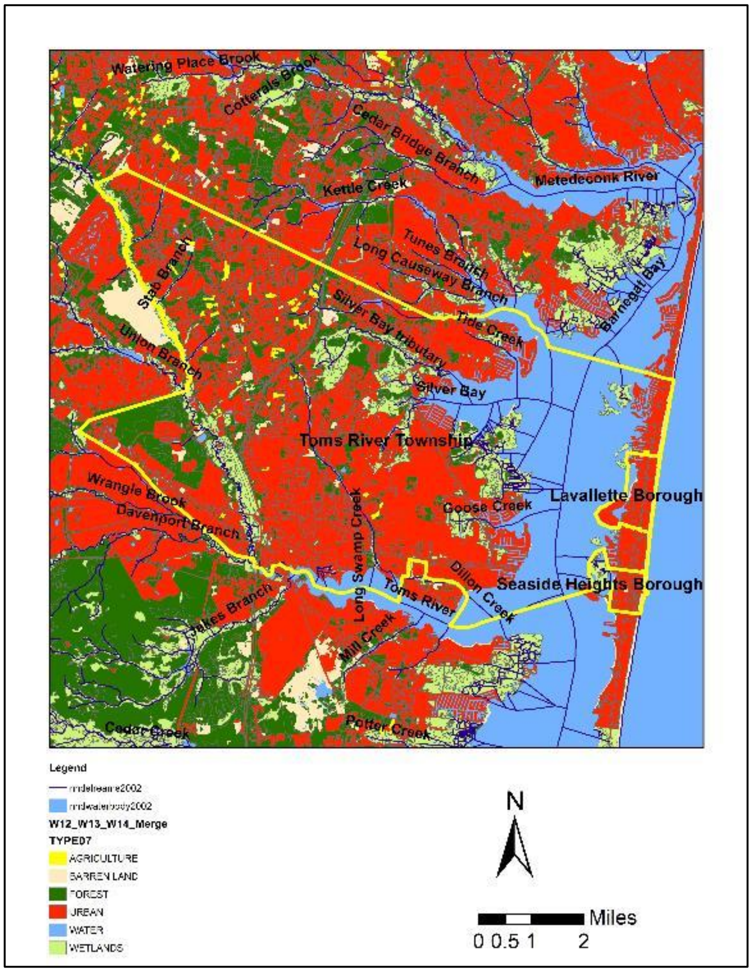


Fig. 1.7.1 Land Use/Land Cover and Waterway Systems in Toms River Township, Lavallette Borough, and Seaside Heights Borough, New Jersey.

Existing Problems:

Fig. 1.7.2 shows the flooded area by Superstorm Sandy. The existing problems are as follows:

- In Toms River Township, the existing bulkheads along Tide Creek, Silver Bay, Goose Creek, Dillon Creek, Toms River, and edge of Barnegat Bay were too low to resist the storm surge. There are no storm surge barriers at the ends of the dredged lagoons.

- Seaside Heights Borough is located in a low-lying area. The existing bulkheads along the bay were too low to resist the storm surge. There are no surge barriers at the lagoon ends. Almost all of the residential properties in this borough were inundated by Sandy.

- Lavallette Borough is also located in a low-lying area. The existing bulkheads along the bay were too low to resist the storm surge. There are no surge barriers at the ends of the dredged lagoons, and there are no check valves at the outfalls to block the backflows from the storm surge and high tide. Almost all the residential properties in the borough were flooded by Sandy.

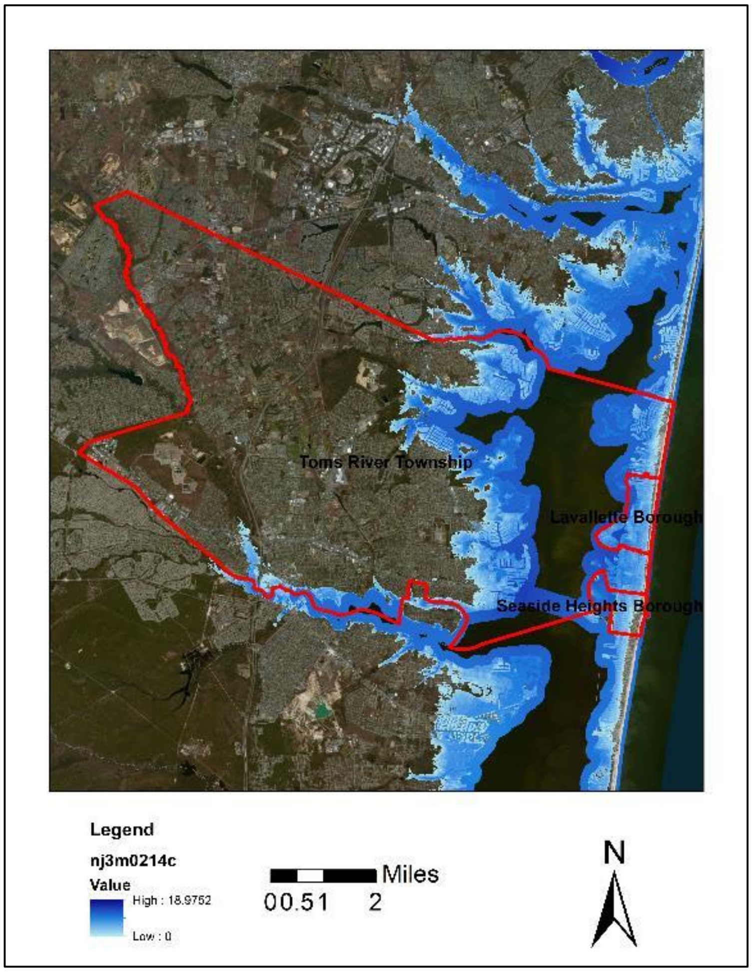


Fig. 1.7.2 Superstorm Sandy Flood Prone in Toms River Township, Lavallette Borough, and Seaside Heights Borough, New Jersey.
(Source: FEMA Modeling Task Force: http://184.72.33.183/GISData/MOTF/Hurricane%20Sandy/)

1.2.4 Stafford Township

Fig.1.8.1 shows the land cover/land use information and waterway systems at Stafford Township, N.J. The red color represents the urban areas, which comprise low percentage of the township.

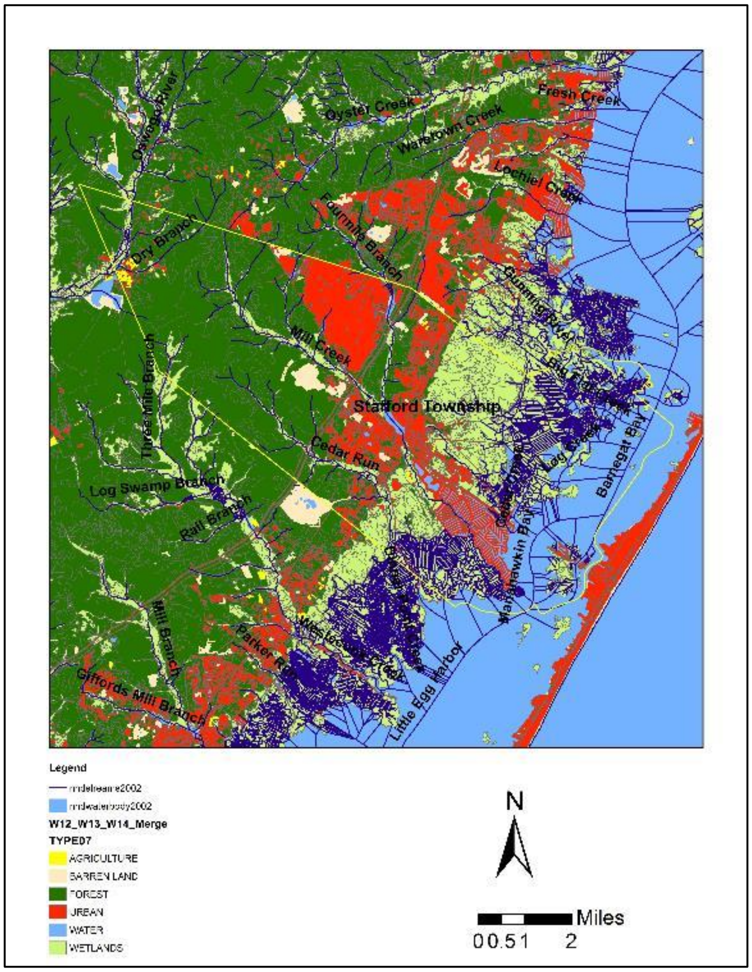


Fig. 1.8.1 Land Use/Land Cover and Waterway systems in Stafford Township, N.J.

Existing Problems:

Fig. 1.8.2 shows the flood extent of Superstorm Sandy. The existing problems are as follows:

- Almost all the urban areas are located in a low-lying area. The existing bulkheads along the dredged lagoons and the Manahawkin Bay are too low to resist the storm surge. There are no storm surge barriers at the ends of the dredged lagoons to block the backflow from the storm surge.

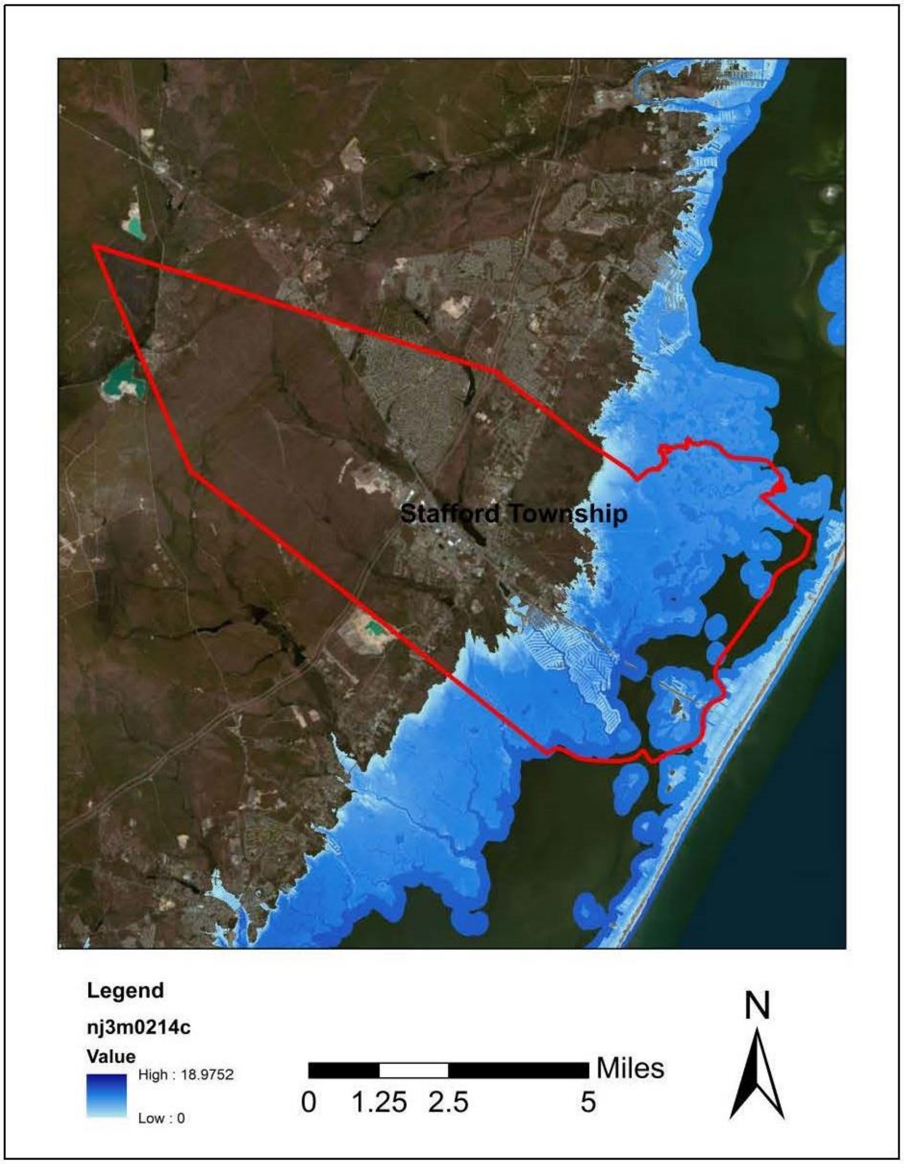


Fig. 1.8.2 Superstorm Sandy Flood Prone in Stafford Township, N.J.
(Source: FEMA Modeling Task Force: http://184.72.33.183/GISData/MOTF/Hurricane%20Sandy/)

1.2.5 Little Egg Harbor Township (including Tuckerton Borough)

Fig. 1.9.1 shows the land cover/land use information and waterway systems at Stafford Township, N.J. The red color represents the urban areas. The urban land cover/land use in this township is less than in the townships and boroughs to the north.

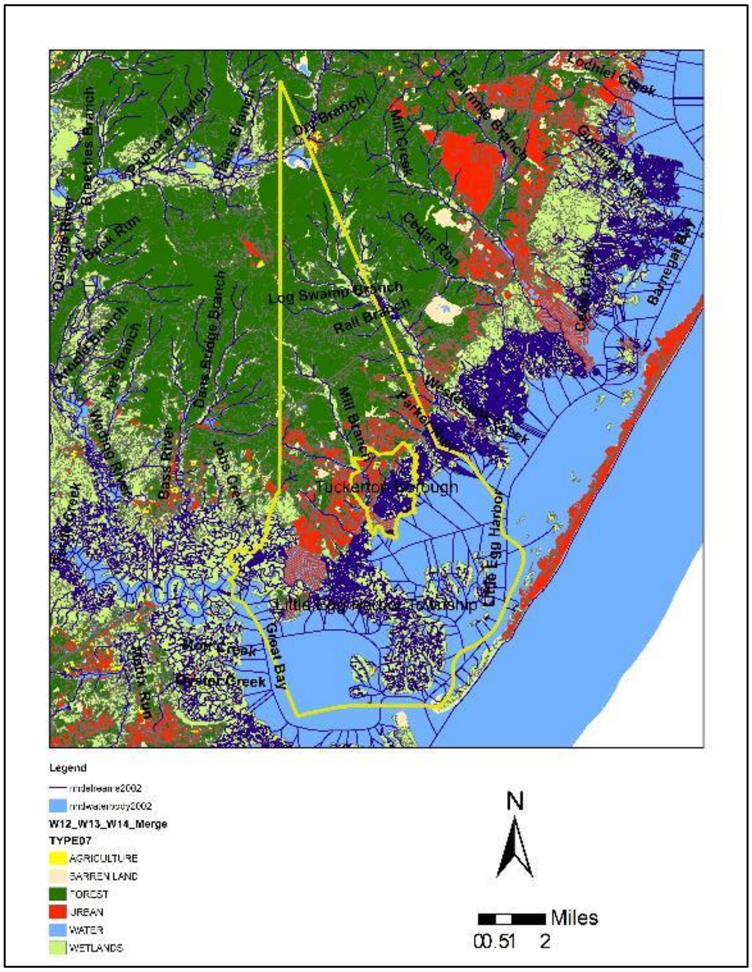


Fig. 1.9.1 Land Use/Land Cover and Waterway systems in Little Egg Harbor Township, and Tuckerton Borough, N.J.

Existing Problems:

Fig. 1.9.2 shows the flood extent of Superstorm Sandy. The existing problems are as follows:

- In Little Egg Harbor, almost all the urban areas are low-lying. The existing bulkheads along the lagoons are low to resist the storm surge; and there are no storm surge barriers at the ends of the dredged lagoons.

- Tuckerton Borough is located in a low-lying area. The existing bulkheads along the dredged lagoons are too low to resist the storm surge. In addition, there are no storm surge barriers at the ends of the dredged lagoons.

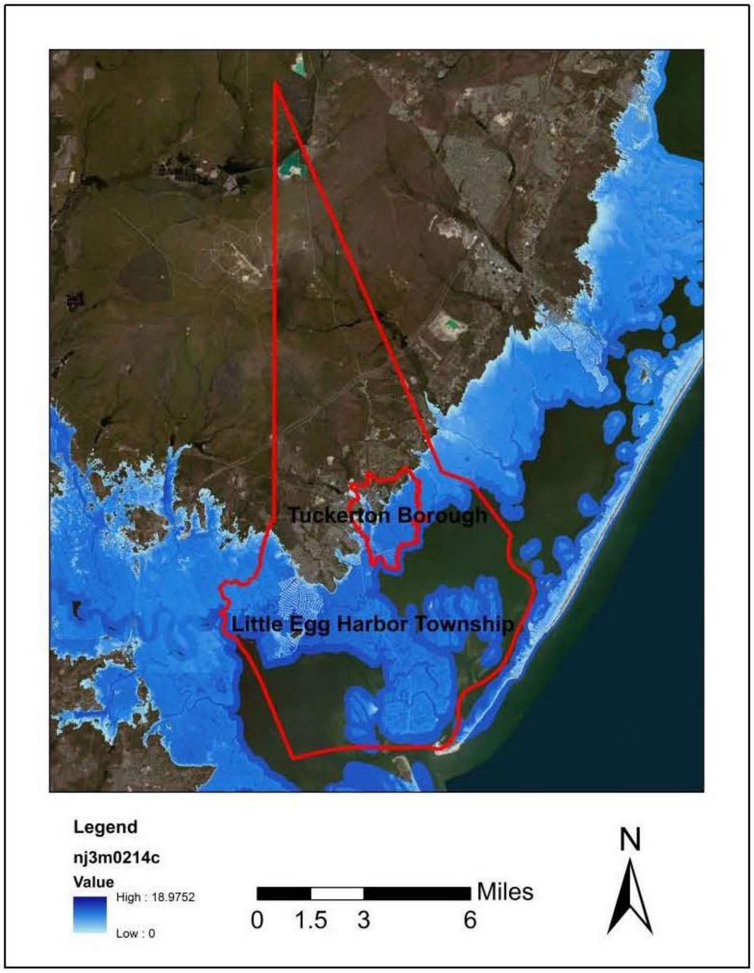


Fig. 1.9.2 Superstorm Sandy Flood Prone in Little Egg Harbor Township and Tuckerton Borough, New Jersey.
(Source: FEMA Modeling Task Force: http://184.72.33.183/GISData/MOTF/Hurricane%20Sandy/)

1.3 Purpose and Methodology

The main purpose of this study is to develop strategic solutions that are novel, feasible, affordable, and environmental friendly for flood defense in the study areas and to help the communities achieve the resilience. Based on the review of existing flood risk reduction measures and specific site conditions, some new strategic solutions are to be provided. They are presented in the following sections. For areas with similar field conditions, these solutions may be applied directly.

The topography of most of the communities considered in this report generally slopes from ocean side toward Barnegat Bay (east to west). The land is relative low and many residences are located at low-lying areas. Some existing storm drainage systems were undersized and do not have the capability for storm events greater than one year at mean high water levels (NJDOT, 2013a). To solve these problems, the general scope, variables, methodology, and flood defense alternatives considered in this study are illustrated in Figs. 1.10.1 and 1.10.2.

Fig. 1.10.1 describes the components of strategy development for coastal flood defense. For coastal flood risk reduction, 10-year, 50-year, and 100-year coastal storms (they are the only available data) coupled with rising sea levels will be employed for the determination and placement of flood defense measures. While for inland flood defense, the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year design rainfalls will be used for the determination of pump capacities and numbers. Fig. 1.10.2 shows a layout overview of flood defense measures for coastal flood risk reduction. Table 1.1.1 provides a listing of each function and its associated measures.

The strategy development framework includes the consideration of (a) all three sources of the threat (the flood water), local rainwater, upstream riverine flow, and downstream coastal water; (b) various levels (recurrence intervals) of the threat and their future changes; (c) types and extents of the exposure/vulnerability including various types of land use and infrastructure; (d) regional, municipal, and neighborhood/block/lot scales of solutions; (e) types of possible flood mitigation measures, (f) functions of possible flood mitigation measures, and (g) costs, benefits, environmental impacts, waterfront accessibility and synergy of the proposed solutions. The types of the measures considered include: maintenance/repair vs. new construction, mobile/adaptable vs. fixed, green/nature-based vs. grey, non-structural (policy, regulation, etc.) vs. structural, micro-grid vs. large-grid powered, innovative vs. conventional, preventative vs. protective, retroactive vs. anticipatory, and short-term vs. long-term. The functions of the measures considered include: (1) rainfall interception, (2) storage, (3) conveyance, (4) upstream flow reduction, (5) diversion, (6) deceleration, (7) tide barrier, (8) pumping, (9) surge barrier, (10) mobile barrier, (11) elevation, and (12) avoidance.

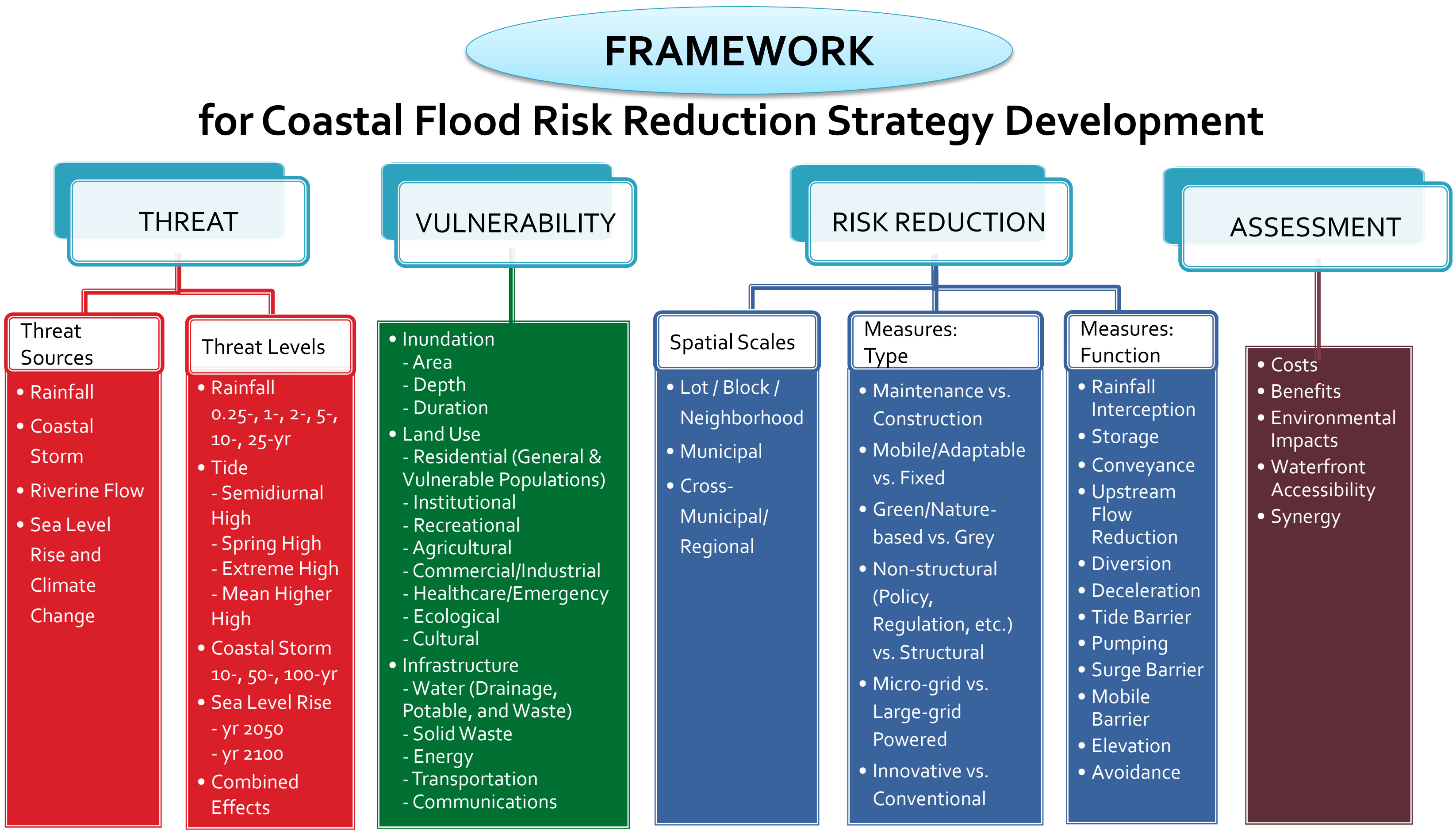


Fig. 1.10.1 Framework for Coastal Flood Risk Reduction Strategy Development

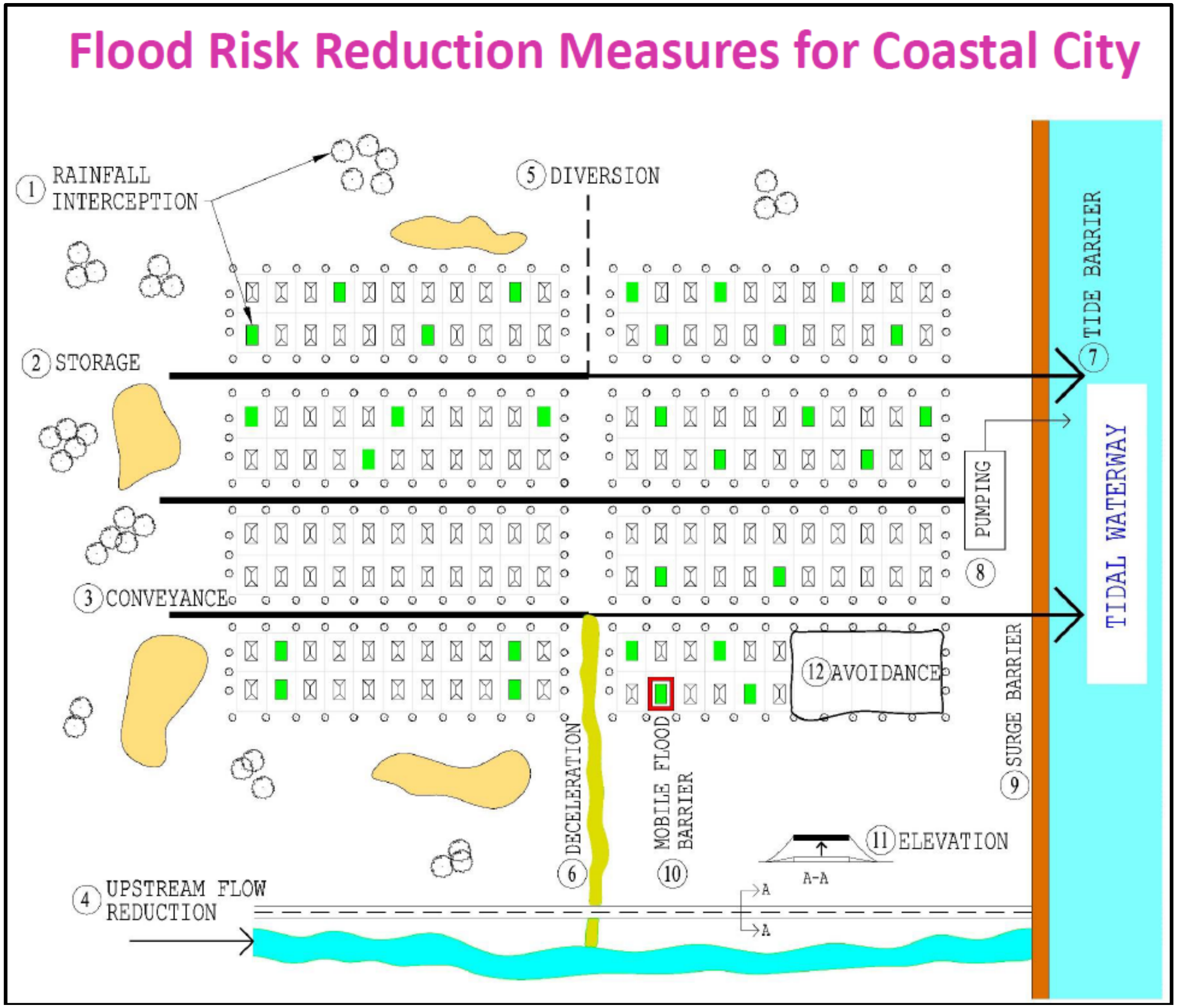


Fig. 1.10.2 An Overview of Flood Risk Reduction Measures for Coastal Flood Defense

Table 1.1.1 Flood Mitigation Functions and Associated Measures

FUNCTIONS AND MEASURES

RAINFALL INTERCEPTION	**STORAGE**	**CONVEYANCE**	**UPSTREAM FLOW REDUCTION**	**DIVERSION**	**FLOW DECELERATION**	**TIDE BARRIER**	**PUMPING**	**SURGE BARRIER**	**MOBILE FLOOD BARRIER**	**ELEVA-TION**	**AVOIDANCE**
INCREASE VEGETATION	RETENTION	SEWER	DAM	NEW SEWER	VEGETATED SWALE	FLAP GATE	PUMPING STATION	NEW LEVEE	MOVABLE FLOOD WALL	ELEVATE BUILDING	BUYOUT
GREEN ROOF	DETENTION	CHANNEL	WATERSHED MANAGE-MENT	BYPASS FORCE MAIN*	ARTIFICIAL WETLANDS	SLUICE GATE	EMERGENCY POWER	SEAWALL	FLOOD GATE	ELEVATED ROAD	EVACUA-TION
BIOSWALE	INFILTRA-TION	DREDGING				HEADWALL	WIND PUMP	TEMPORARY SEAWALL	INFLAT-ABLE BARRIER		WARNING
VEGETATED FILTER STRIP	EXPANSION	COMBINED SEWER SEPARATION					RAIN PUMP*	ELEVATING LEVEE			RISK EDUCATION
POROUS PAVING	CONSTRUCTED WETLANDS	CULVERT SIZE					WAVE PUMP*	NEW DUNES			
RAIN GARDEN	LAKE EXPANSION	DEBRIS REMOVAL					CURRENT PUMP*	BEACH NOURISHMENT			
PLANTER BOX		DE-SNAGGING						ARTIFICIAL WETLANDS			
RAIN BARREL		STRAIGHTEN-ING						SHEETING BULKHEAD			
SOIL AMENDMENT		SEWER FLUSHING						CONCRETE BULKHEAD			
VERTICAL WALL								REPAIR LEVEE			
								VEGETATED LEVEE			
								BREAKWATER			
								IN-WATER BARRIER			
								RESTORED WETLANDS			
								LIVING SHORELINE			
								FLOATING BARRIER			
								EXTENDABLE FLOOD PANEL*			
								CAUSEWAY WITH OPERABLE FLOOD GATE*			

*Newly proposed.

II THREAT OF SEA LEVEL RISE

Coasts are sensitive to sea level rise. A rise in sea level and coastal subsidence will increase the levels of flooding, and the low-lying areas will be permanently inundated. Global warming has raised global sea level about 8 inches since 1880 (US EPA). It is predicted that global mean sea level rise from 1990 to 2100 will be between nine and eighty eight centimeters (Nicholls, 2002).

Most models indicate that flooding will continue to worsen as sea surface elevation increases because all storms will be operating on a higher water level at the outlet. Model predictions by the Intergovernmental Panel on Climate Change (IPCC) indicate a rapid sea level rise for the Northeast Atlantic Coast of the United States in the twenty-first century (Yin et al., 2009). In the NY/NJ metropolitan region, sea levels are predicted to rise by 18–60 cm by the 2050s, and 24–108 cm by the 2080s over late 20th century levels (Gornitz et al., 2010; Cahoon and Gunttenspergen, 2010). This means that coastal flooding associated with sea level rise will become a significant issue in the next 100 years

Relative sea level rise around Barnegat Bay results from ongoing coastal subsidence since the end of the last glacial period as well as eustatic sea level rise caused by melting glaciers and thermal expansion of the ocean. Increases in sea level and runoff have severely stressed existing stormwater infrastructure such as storm sewer pipes, drainage ditches, culverts, detention basins, and household sump pumps. The infrastructure is in need of significant improvements and may need to be redesigned to deal with changing conditions.

The following flood maps (Fig. 2.1) show the predicted extent of inundation at Mean Higher High Water (MHHW) when the water in Barnegat Bay rises 1ft, 2ft, 3ft, 4ft, and 6ft for Seaside Heights Borough. The green color represents the low-lying areas. The portrayals of the extent of inundation for other townships / boroughs are provided in Appendix A.

(1) **MHHW (SLR = 0 ft)**

(2) SLR = 1 ft

(3) SLR = 2 ft

(4) SLR = 3 ft

(5) SLR = 4 ft **(6) SLR = 6 ft**

Fig. 2.1 Extent of Inundation when SLR = 0ft, 1ft, 2ft, 3ft, 4ft, and 5ft

Currently, the bayside flooding problems have been exacerbated by sea level rise after the existing storm drainage system was constructed. Fig. 2.2 shows an outfall of a storm sewer in Seaside Heights at a normal tide elevation; even at the normal tide level, the drainage pipe is already about half full of water. That is, the water draining capability of the storm sewer has been reduced to half or less. For the same magnitude of rainstorm, the rainwater will more likely be backed up to the street level, causing flooding.

Fig. 2.2 An Outfall of a Storm Sewer at a Normal Tide Elevation in Seaside Heights, New Jersey Showing the Storm Sewer is about Half Full of Water (photo taken in April 2013).

III DETERMINATION OF FLOOD PROTECTION LEVELS

The flood water surface levels are key design factors for flood defense. The water levels at which populations are to be protected are normally determined by hydrologic and hydraulic simulations or with the data from historical records.

3.1 10-year, 50-year, and 100-year Coastal Flood Maps

For Barnegat Bay, only the Storm Surge Stillwater Elevation (SWEL) grids for the 10-year, 50-year, 100-year, and 500-year recurrence intervals are available in the FEMA Region II website. At a specific location for a given flood protection level, the required height of a flood defense measure to be placed is determined in terms of the flood water depth. Therefore, it is necessary to convert to flood elevations into flood depths. They can be determined by deducting the ground elevations from the flood elevations.

Based on the SWEL grids and Digital Elevation Model (DEM), for the 10-year, 50-year, and 100-year coastal storm recurrence intervals the derived flood prone and depth grid with GIS tool for Toms River Township, Seaside Heights Borough, and Lavallette Borough, are shown in Figs. 3.1a, 3.1b, and 3.1c. In this study, they are used as the basis for the placement of the flood defense measures. The maps for the rest of the study areas are provided in Appendix C.

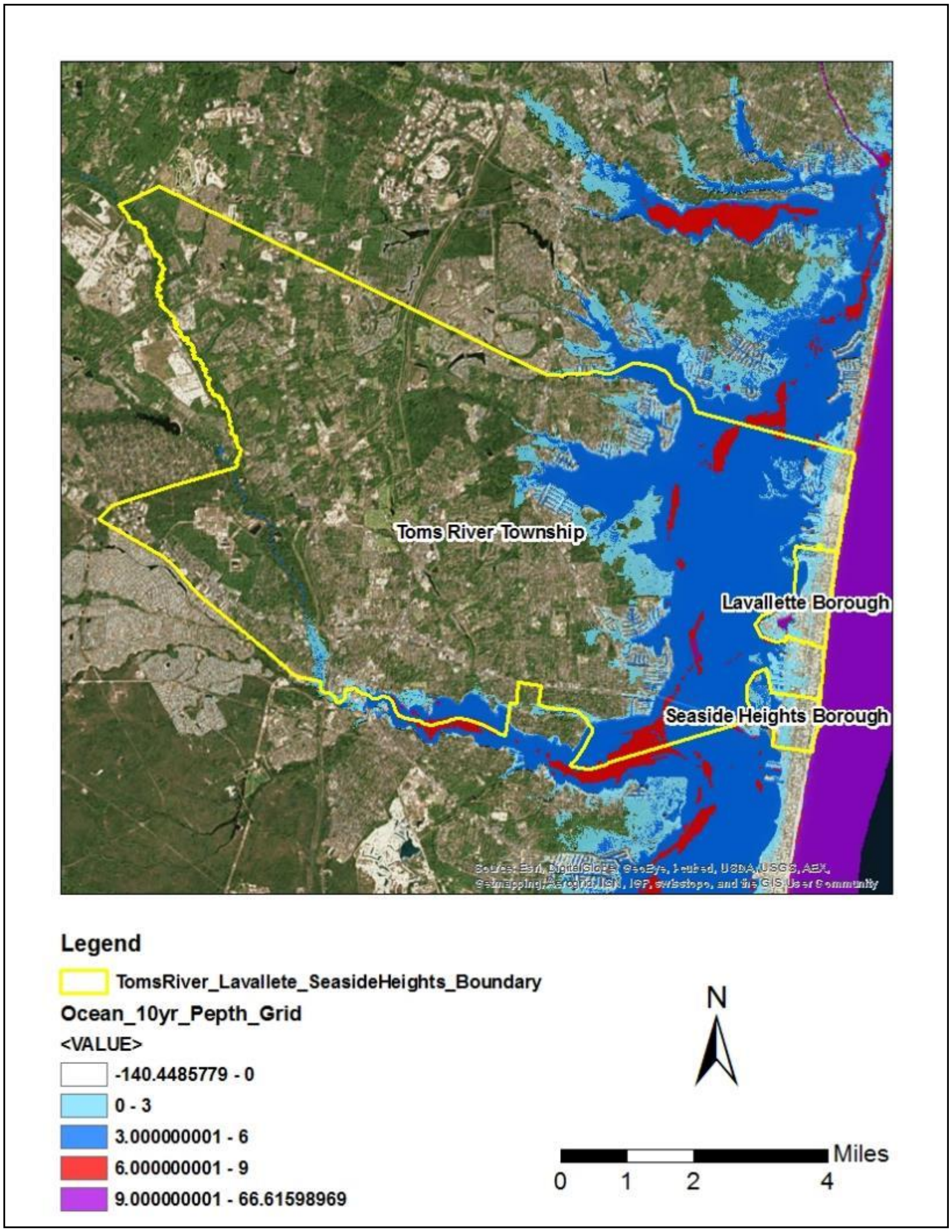


Fig. 3.1a Flood Prone and Depth Grid for 10-Year Storm Recurrence Interval Derived from FEMA Region II SWEL and DEM.
(Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

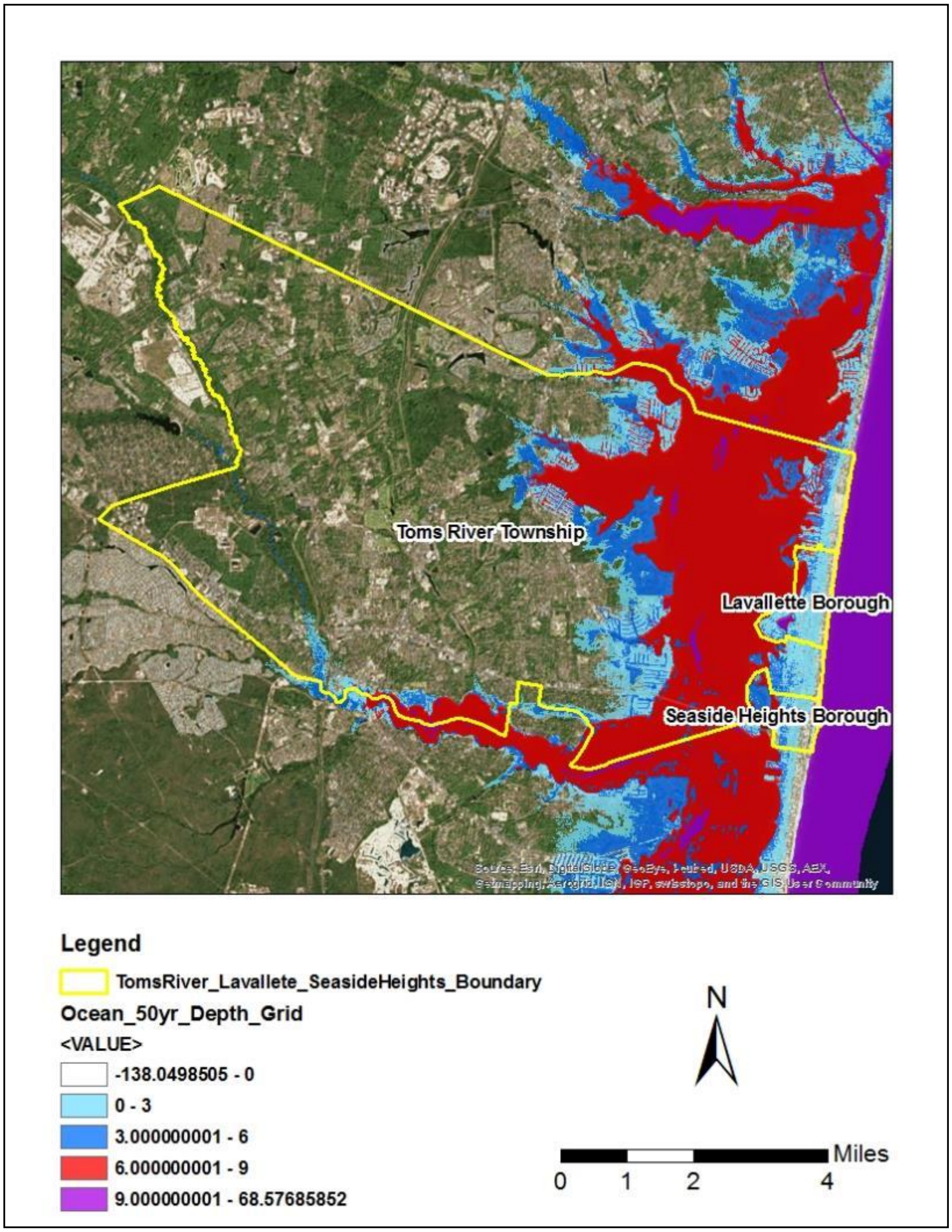


Fig. 3.1b Flood Prone and Depth Grid for 50-Year Storm Recurrence Interval Derived from FEMA Region II SWEL and DEM.
(Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

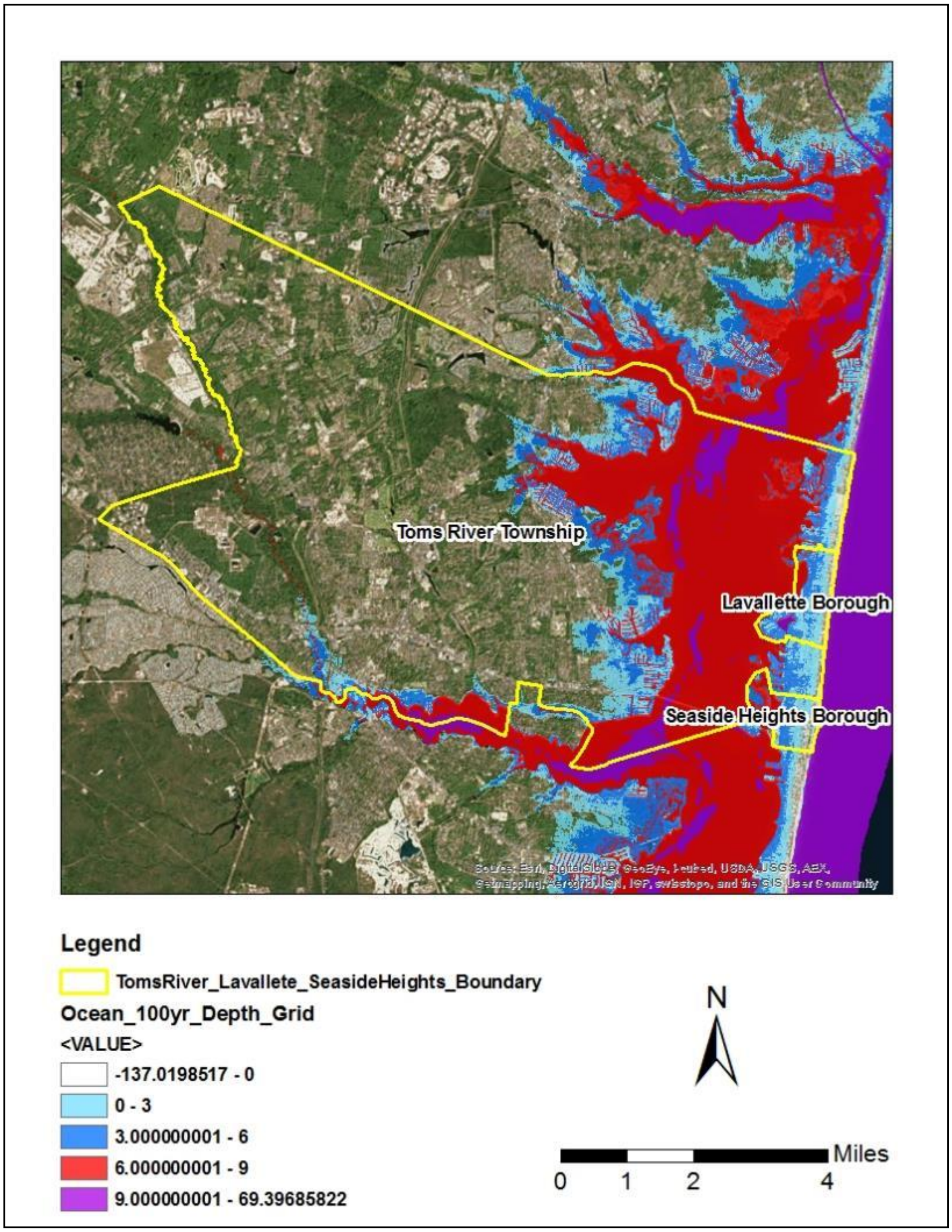


Fig. 3.1c Flood Prone and Depth Grid for 100-Year Storm Recurrence Interval Derived from FEMA Region II SWEL and DEM.
(Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

3.2 Flood Protection Levels

Based on the FEMA 10-year, 50-year, and 100-year storm recurrence interval analysis, the average water surface elevation differences among these three costal storm events in Barnegat Bay are illustrated in Fig. 3.2. Based on the examination of the flood depth, the 10-year flood water depth is normally less than 1 ft above the ground (Fig. 3.1a). The difference between 10-year and 50-year coastal storm water elevations is 1.96 ft within the bay, while the difference between 50-year and 100-year coastal storm water elevations is 0.76 ft. For long-term planning, the effect of sea level rises (SLR) should be considered. For Barnegat Bay, the projected SLRs in the years of 2050 and 2100 are 1.5 ft and 3.5 ft, respectively (Miller, et al., 2013).

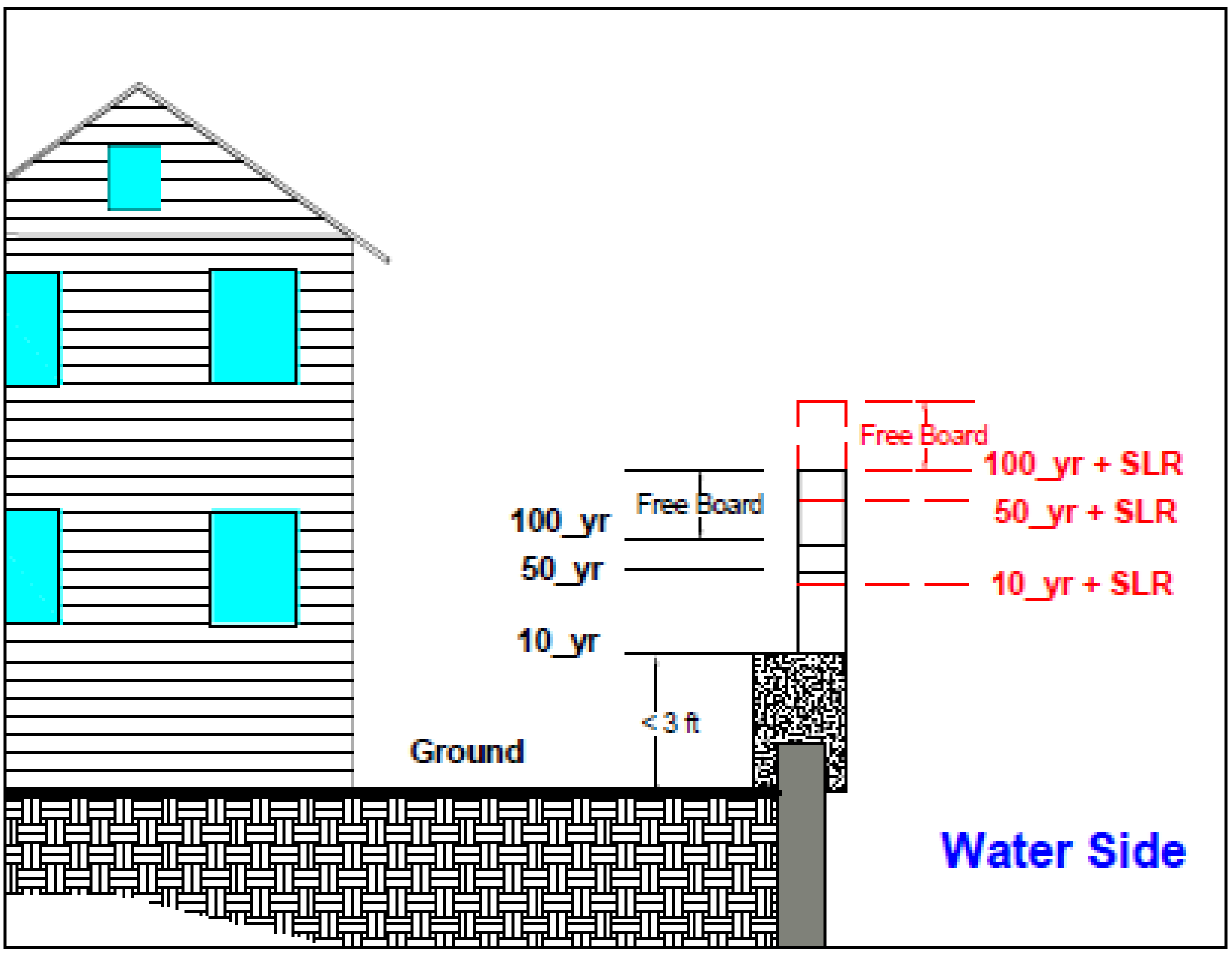


Fig. 3.2 Illustrative Sketch of Flood Protection Levels

3.3 Design and Construction Considerations

Three conditions should be considered in the design and construction of flood defense structures.

1. If the proposed height of the flood defense structures for the required water protection levels (i.e., design flood elevations (DFE)) will not block the view of the residences (e.g., less than 3 ft), the permanent flood defense structures are preferred.

2. If the flood defense structure were too high and would block the view, the defense measures should be constructed with two parts: (1) bottom permanent structure, (2) and top movable structure. The height for the bottom permanent structure can be set to the 10-year storm level, and it also serves as the foundation for the top movable structure. For the 10-yr storm in the Barnegat Bay, the flooding water depths are normally less than 1 ft. The movable flood defense structures are connected on the top of the permanent structures and positioned on the water side to be raised in the events of the 50-year or 100-year floods. Whenever the storm events are greater than the 10-year storm, the movable structures will be raised to increase the height of the flood defense measures. However, when the floods recede, the movable structures will be moved back to their hanging position. Its working positions are presented in Section IV.

3. If the flood defense structure were too high and would block the view, and the current budget is not enough to build flood defense measures for protecting the high water levels such as 50-year or 100-year storms, the construction may be divided into two phases. In phase 1, the height of the permanent flood defense structures should be set to the 10-year flood protection level, and the adapters should be embedded at the top of the permanent structures for installing movable structures in the future. In phase 2, if the new budget were available, the movable flood defense structures should be installed on the permanent structures through the adapters installed in phase 1.

IV LIST OF PROPOSED FLOOD DEFENSE MEASURES

Based on the topographic analysis and specific field conditions, the proposed flood defense measures for Barnegat Bay include:

1) **Construct new metal sheet bulkheads with or without movable panels and incorporate check valves inside the bulkheads**
2) **Construct new concrete flood walls with or without movable flood panels and incorporate check valves inside the walls**
3) **Increase existing bulkhead height by adding movable/removable panels**
4) **Construct movable/removable flood panels**
5) **Construct new levee/dike including culvert or pipe with flap gate/check valve**
6) **Elevate the residences**
7) **Raise roadways**
8) **Construct sluice gates or in-water barriers**
9) **Construct flood gates**
10) **Construct pump stations**

The other types of the available flood defense measures are provided in Appendix B. The following are some examples of flood defense measures selected in the study. The detailed flood defense measure placement for each township/borough is presented in the next section.

4.1 Construct New Bulkhead with or Without Movable Panels

For locations without flood defense measure and with limited space, construction of new bulkhead are prefered. Fig. 4.1 shows an example of a location proposed for new bulkhead construction. The red line represents the location of bulkhead.

If the height of a proposed flood defense structure is too high and blocks the view from the residences, it will not be accepted by the public although the protection goal can be achieved. Therefore, to satify both the public acceptance and the protection goal, some new strategies should be developed. In this study, two new types of bulkhead with movable flood panels are developed.

Fig. 4.1 Constructing New Metal Sheet Bulkhead with or Without Movable Flood Panel

4.1.1 Conceptual Design for Type 1

The Type 1 system (Fig. 4.2.1) consists of a bulkhead incorporating outfall pipes and flap gate/check valve, with a concrete cap (permanent structure) over the bulkhead, and rotational flood panels 1 and 2 connected on the concrete cap through rotational axis 1. Panel 2 is connected with panel 1 through axis 2. The related drainage components (such as a local drain to a pump station) are also indicated.

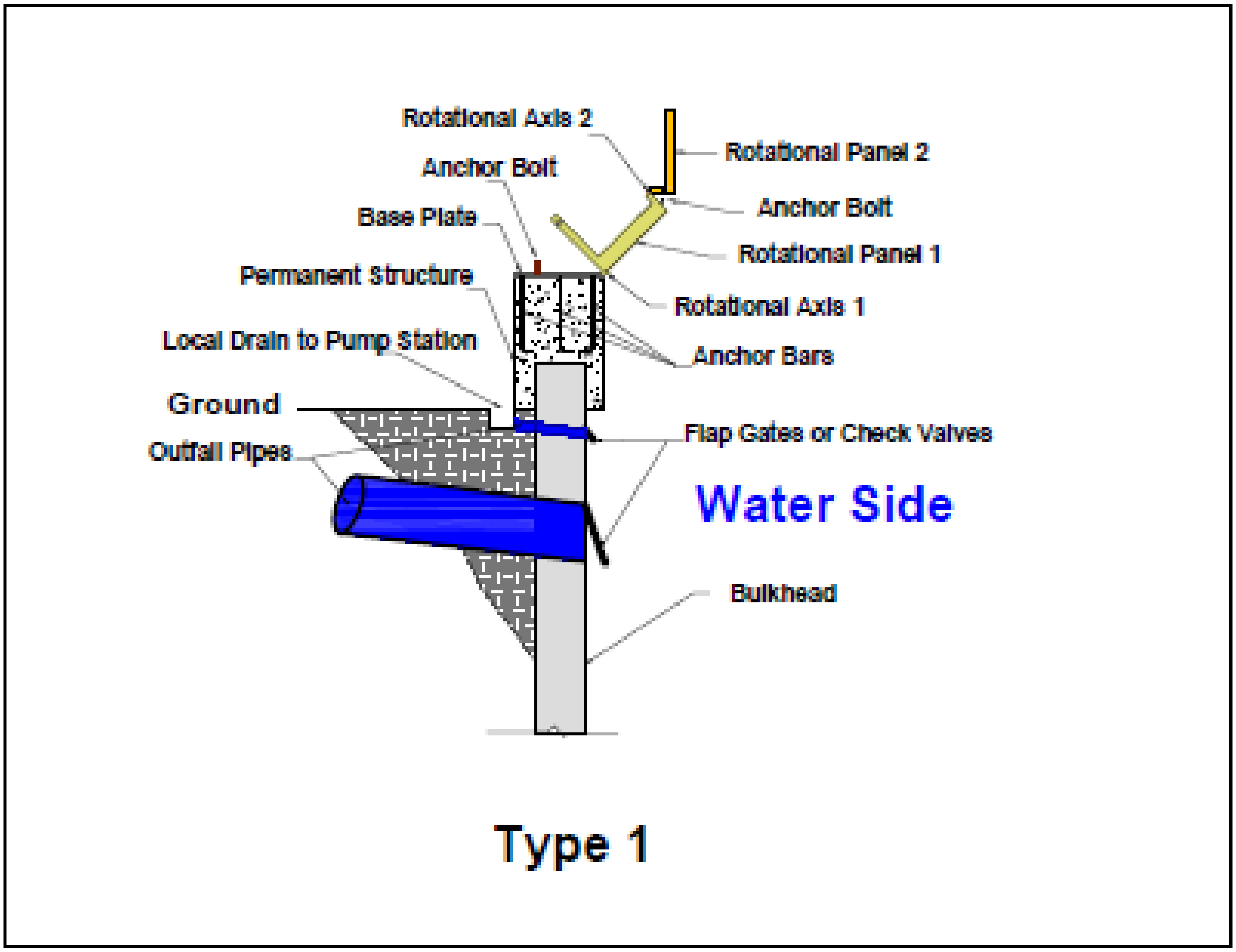


Fig. 4.2.1 Illustration of Bulkhead with Movable Flood Panels for Type 1

Under different water protection levels, the positions of movable flood panels are shown in the Figs. 4.2.2, 4.2.3, 4.2.4, and 4.2.5. In this study, for water protection level 1 (e.g., 10-yr storm), the permanent structure (bulkhead concrete cap) will be used for flood defense. In terms of the flood data analysis, the flood water depths at Barnegat Bay for 10-year storm are less than 3 ft. Therefore, by considering the public acceptance and the structural strength requirement to support the movable panels, the height of the permanent structures (bulkhead concrete cap) can be set to 3 ft. The determination of thickness should be based on the detailed structural analysis with the combination of various forces acting on it. If necessary, piles should be installed under the bulkhead concrete cap along the inland side to increase the rigidity and strength of the system.

The construction of the permanent structure (bulkhead with concrete cap) will block the natural overland as well as surface flows into the receiving water. To solve this problem, local drains or sumps along the landward of the permanent structure, having seaward outlets should be constructed (Fig. 4.2.1). Under normal rainfall events, i.e., the water levels at local drains are higher than that at receiving waters, the inland flood water can be directly discharged into the water body by gravity.

However, under extreme weather conditions, such as high tide or storm surge combined with heavy rainfall, the water levels on the seaward side of the bulkhead may be higher than that at the inland side. Thus, the inland flood water will not be able to drain by gravity. Under this situation, the flap gates or check valves at the outfalls will be automatically closed and the movable flood panels, if necessary, will be raised to block the oncoming storm surge. However, the inland flood water will be collected by the local drains, and will flow to the pump stations to be discharged. Only under the high tide or storm surge condition, the flap gates or check valves will be automatically closed and the movable flood panels will be raised to block the oncoming water.

The working positions of the movable flood panels, based on the different water protection levels, are illustrated in Figs. 4.2.2, 4.2.3, and 4.2.4, respectively. An overview of the working positions of the movable flood panels for the different water protection levels is shown in Fig. 4.2.5.

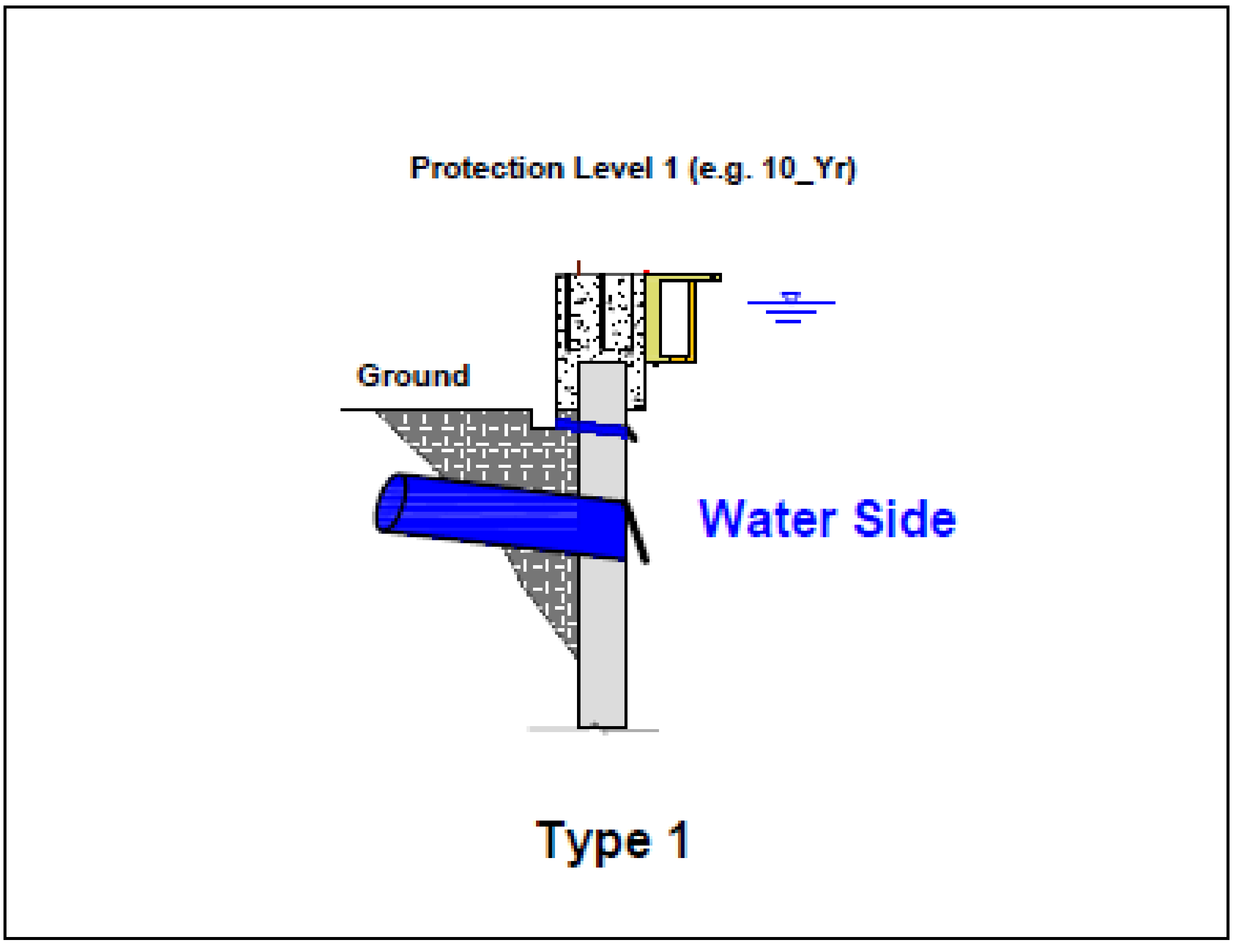


Fig. 4.2.2 Movable Panel Position for Protection Level 1 (e.g., 10-yr) for Type 1

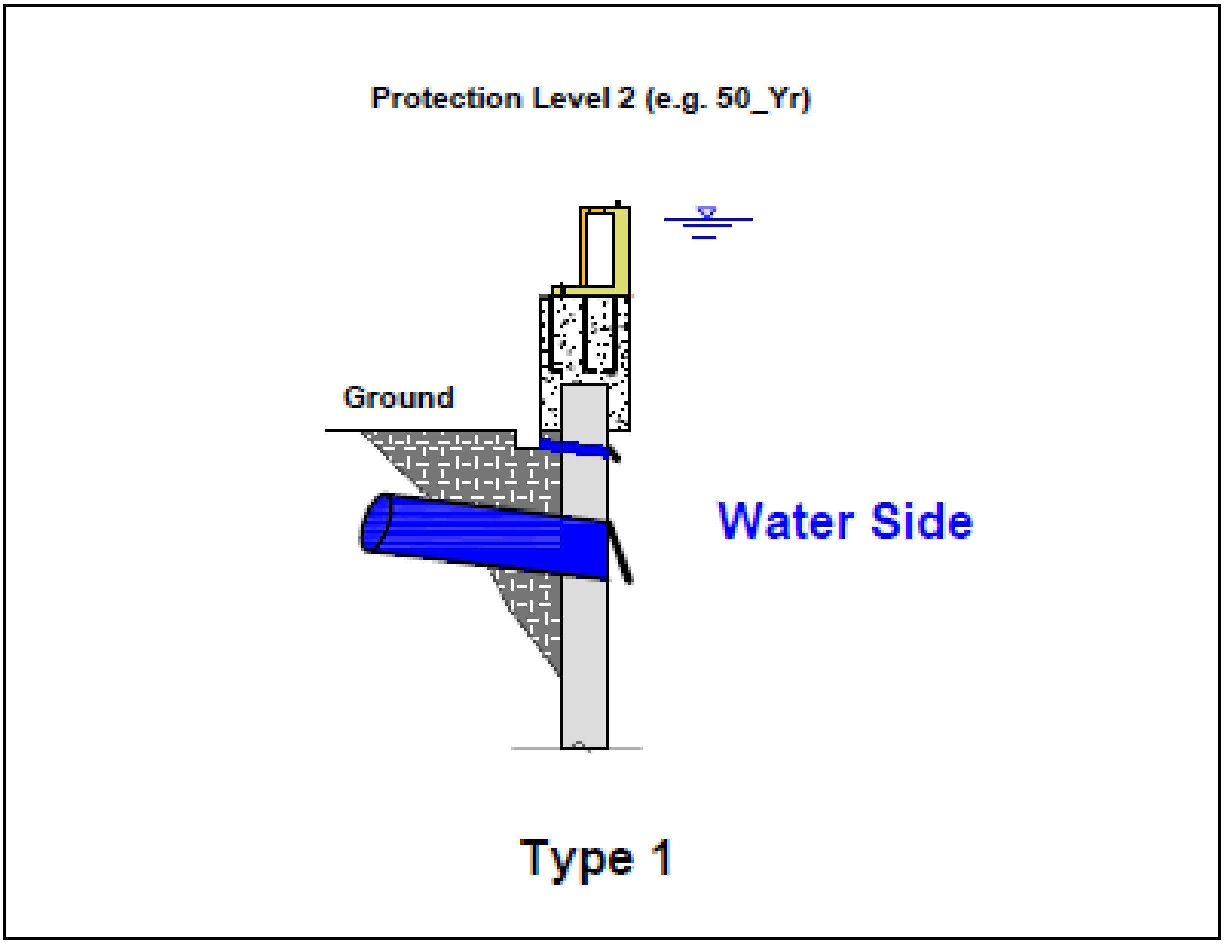


Fig. 4.2.3 Movable Panel Position for Protection Level 2 (e.g., 50-yr) for Type 1

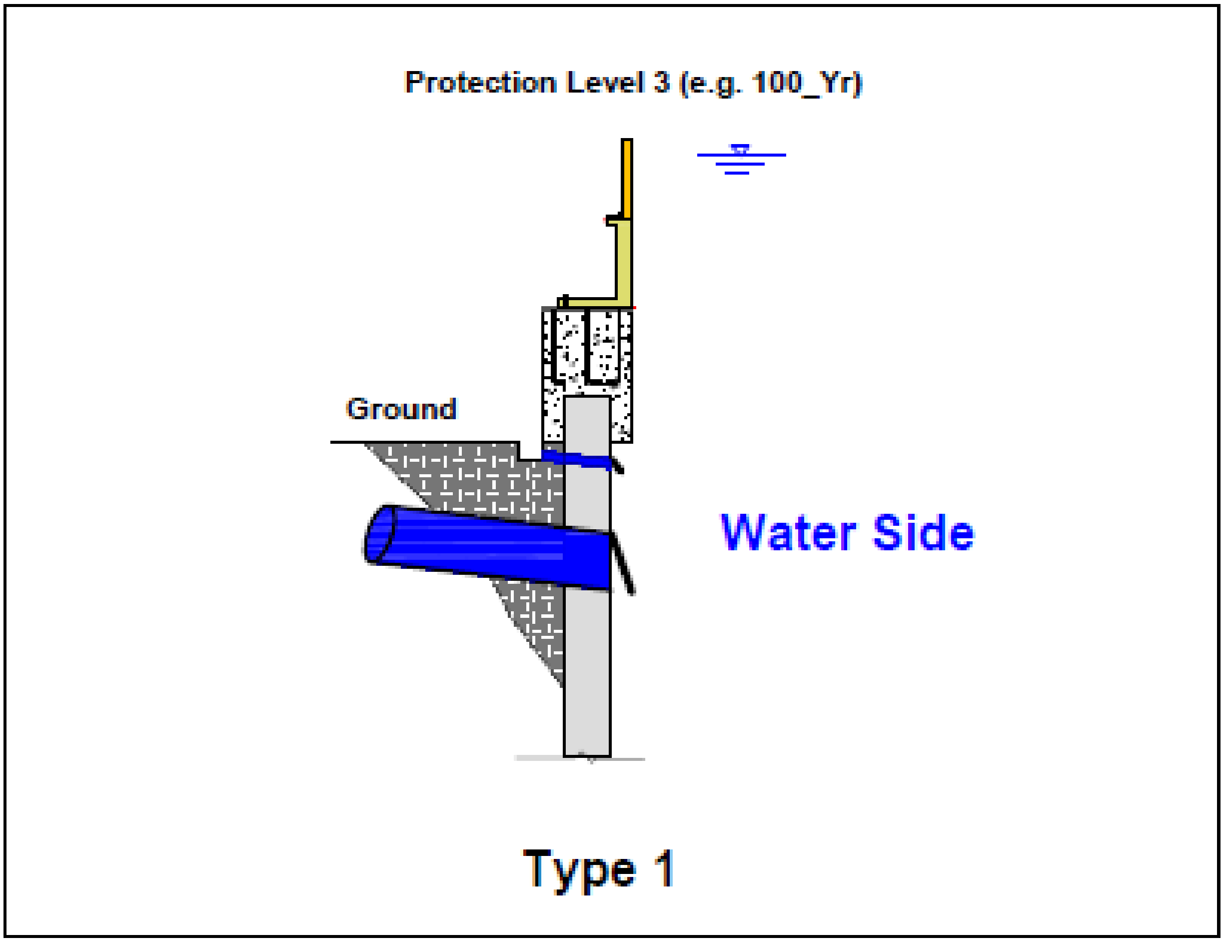


Fig. 4.2.4 Movable Panel Position for Protection Level 3 (e.g., 100-yr) for Type 1

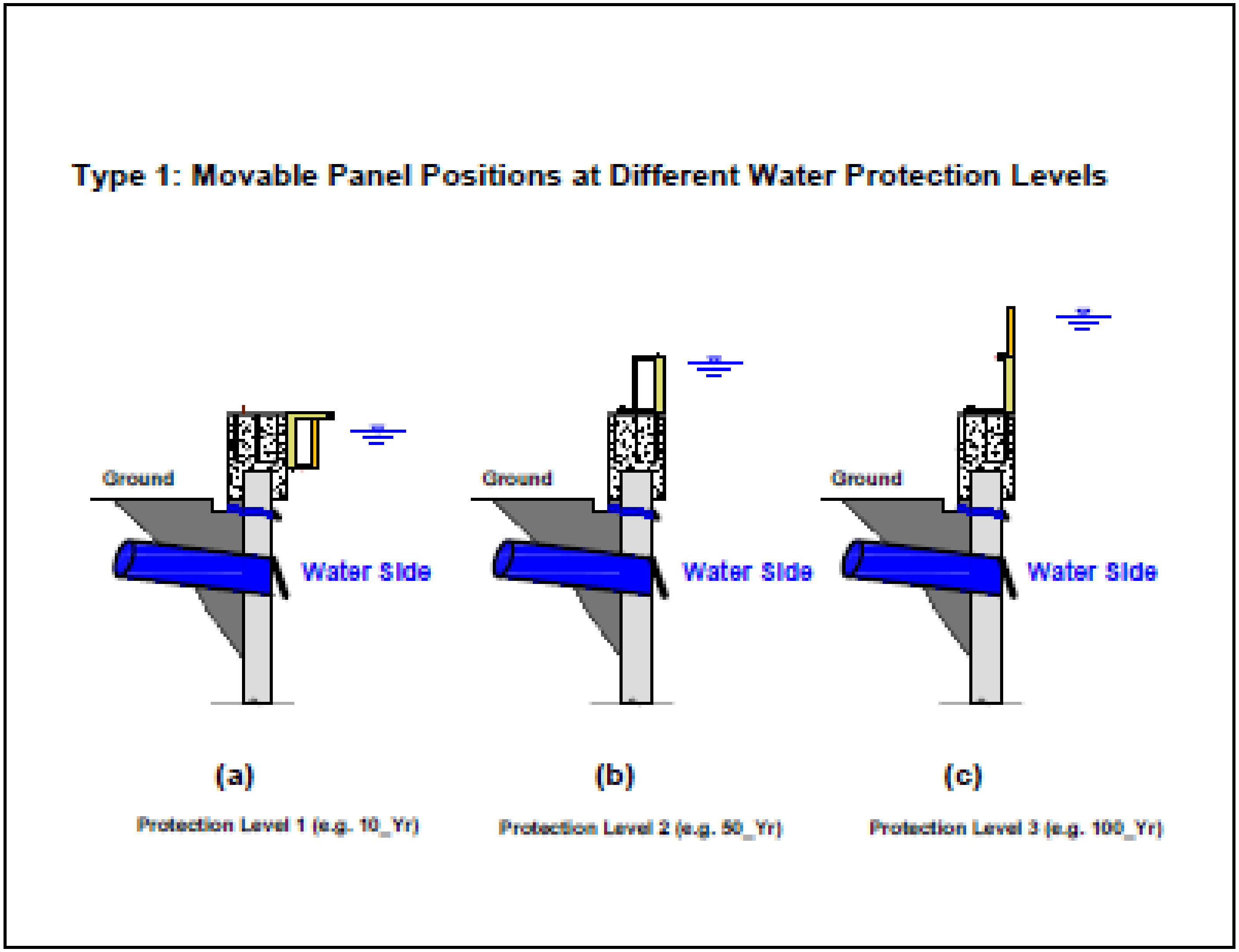


Fig. 4.2.5 Overview of Movable Panel Positions at different Water Protection Levels for Type 1

4.1.2 Conceptual Design for Type 2

The conceptual design for the Type 2 system consists of bulkhead with outfalls and flap gate/check valve, concrete cap (permanent structure) over the bulkhead, rotational flood panel 1 and movable panel 2 connected on the concrete cap through rotational axis. The movable panel 2 is attached on the rotational panel 1 through bolts, that can move parallel to the rotational panel 1. The related drainage components are also indicated in Fig.4.3.1. The major difference between Type 1 and Type 2 is that for Type 1, Panel 2 rotates about Panel 1 (Fig. 4.2.1); while for Type 2, Panel 2 moves parallel to Panel 1 (Fig. 4.3.1).

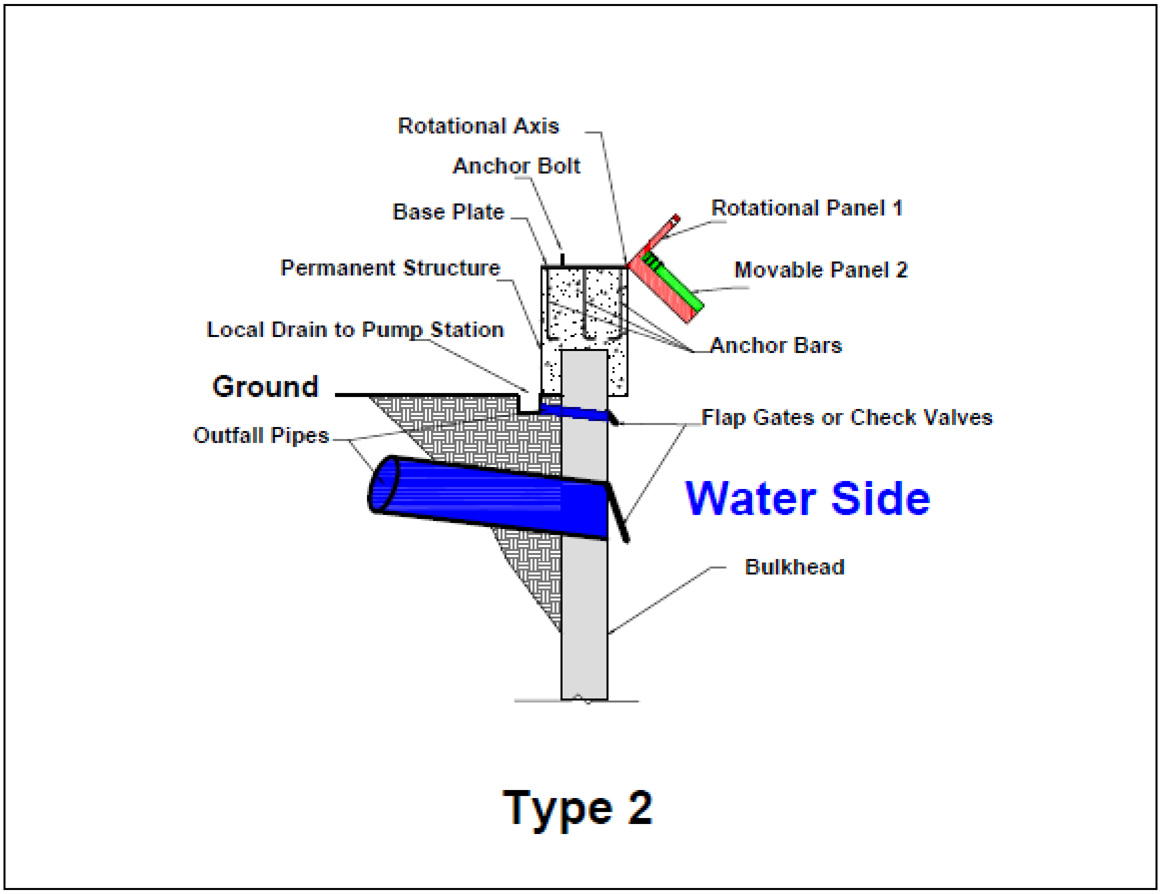


Fig. 4.3.1 Illustration of Bulkhead with Movable Flood Panels for Type 2

Type 2 working principles are similar to that described for Type 1. The working positions of the movable flood panels, based on the different water protection levels, are illustrated in Figs. 4.3.2, 4.3.3, and 4.4, respectively. An overview of the working positions of the movable flood panels for the different water protection levels is shown in Fig. 4.3.5.

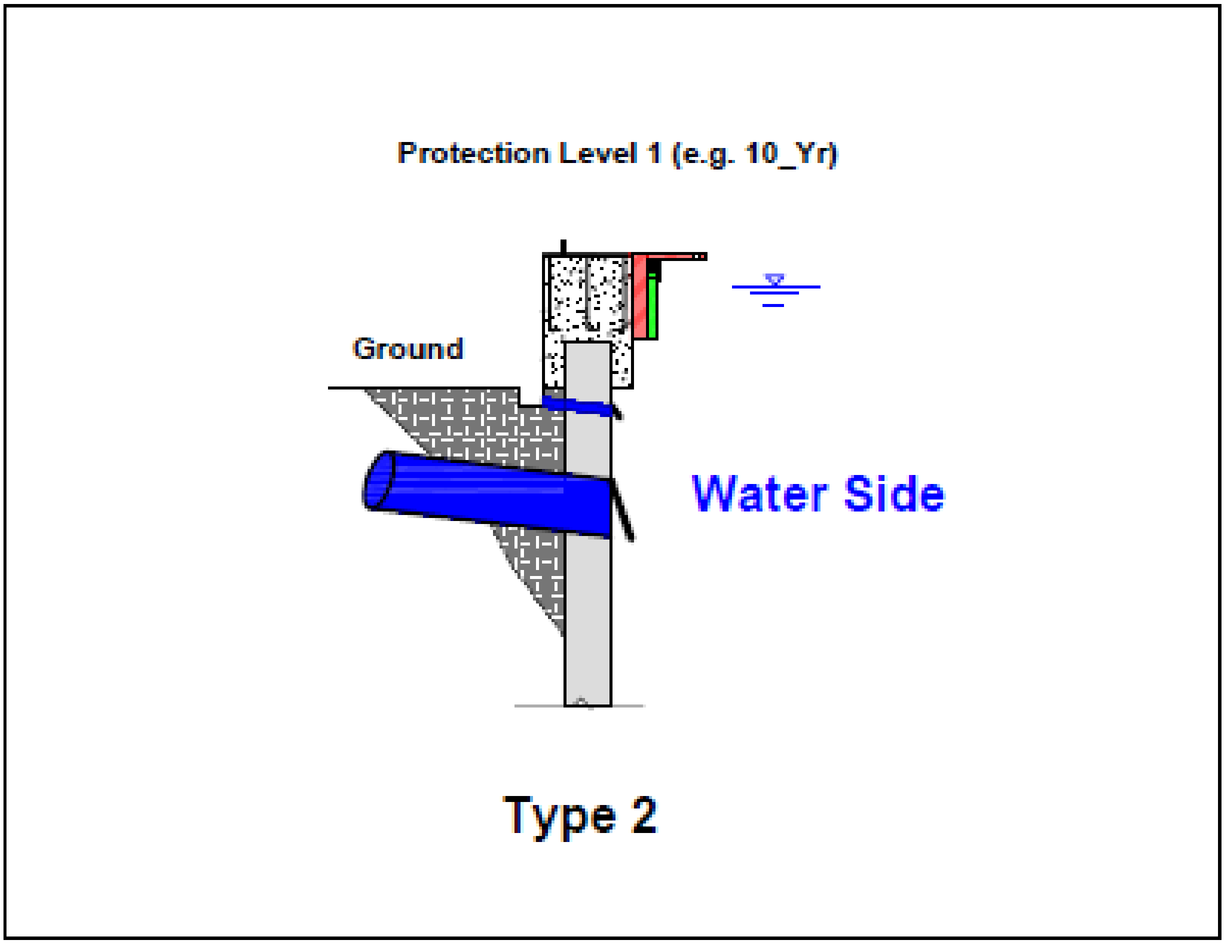


Fig. 4.3.2 Movable Panel Position for Protection Level 1 (e.g., 10-yr) for Type 2

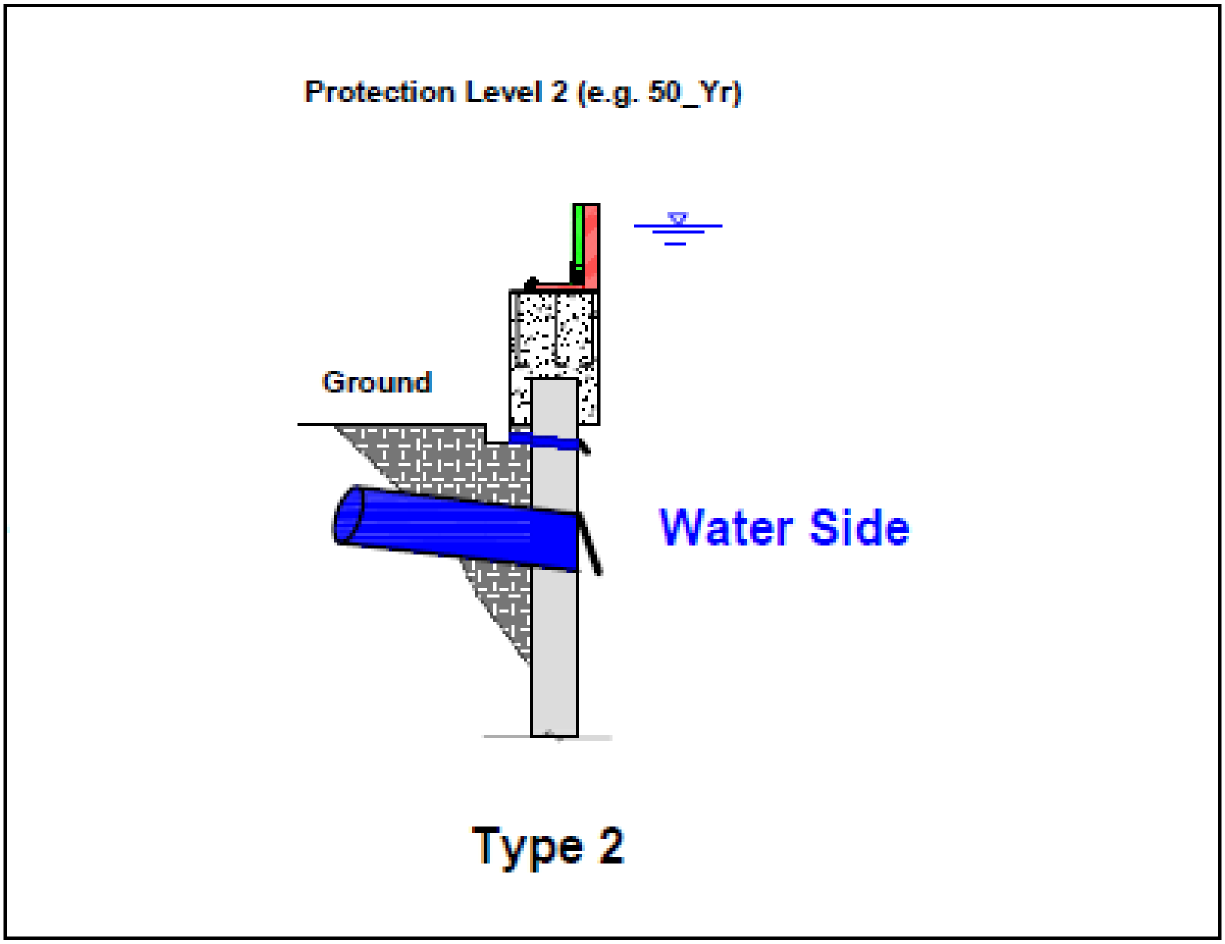


Fig. 4.3.3 Movable Panel Position for Protection Level 2 (e.g., 50-yr) for Type 2

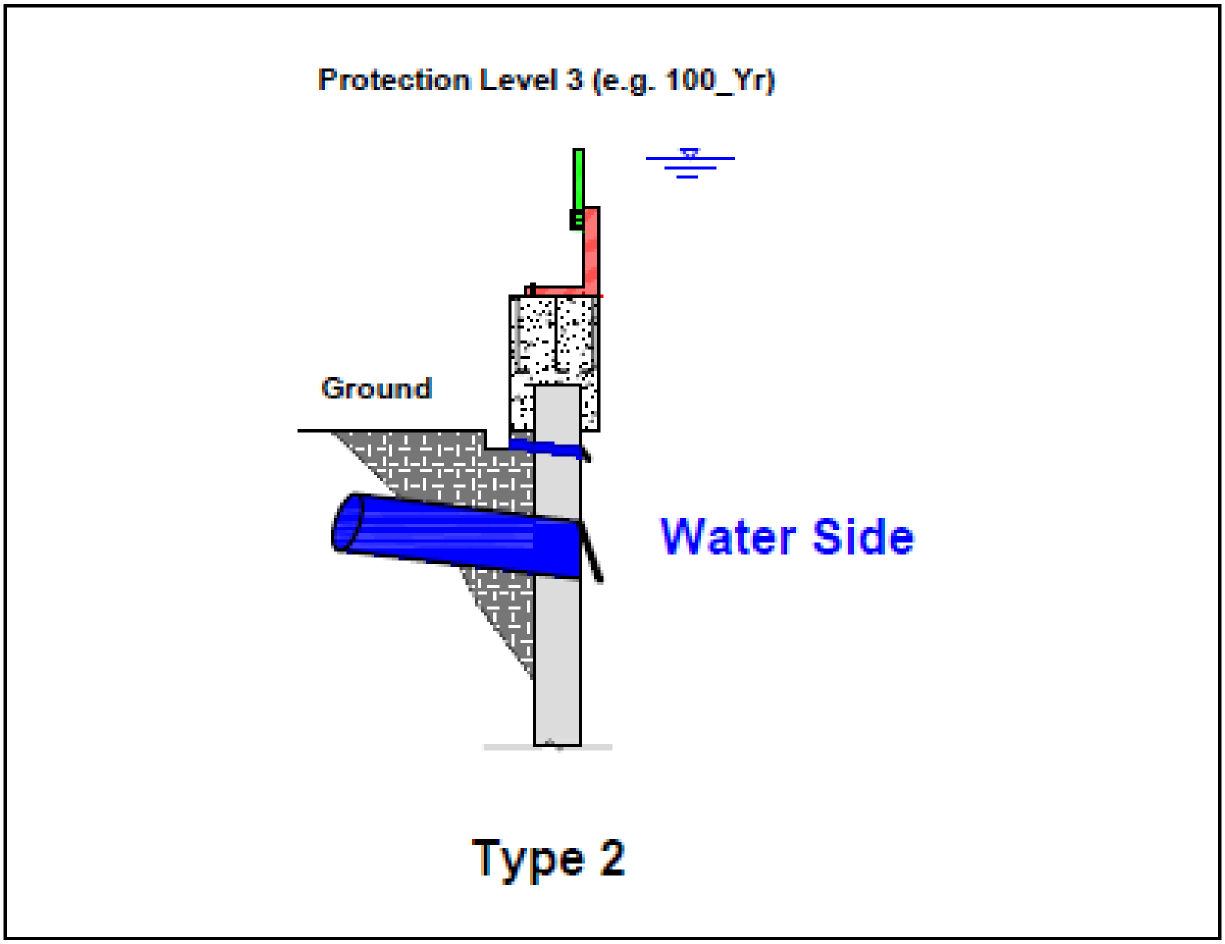


Fig. 4.3.4 Movable Panel Position for Protection Level 3 (e.g., 100-yr) for Type 2

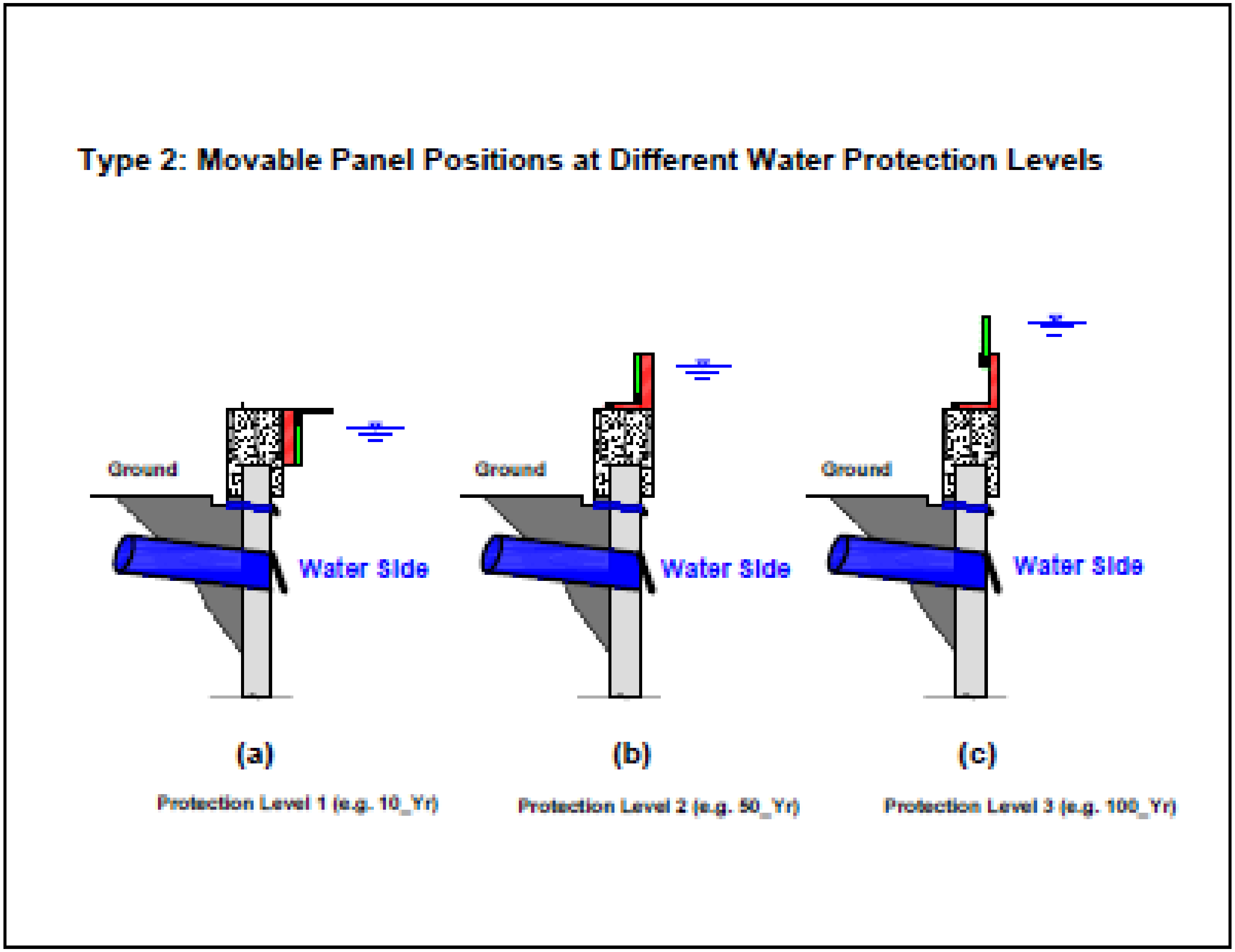


Fig. 4.3.5 Overview of Movable Panel Positions at different Water Protection Levels for Type 2

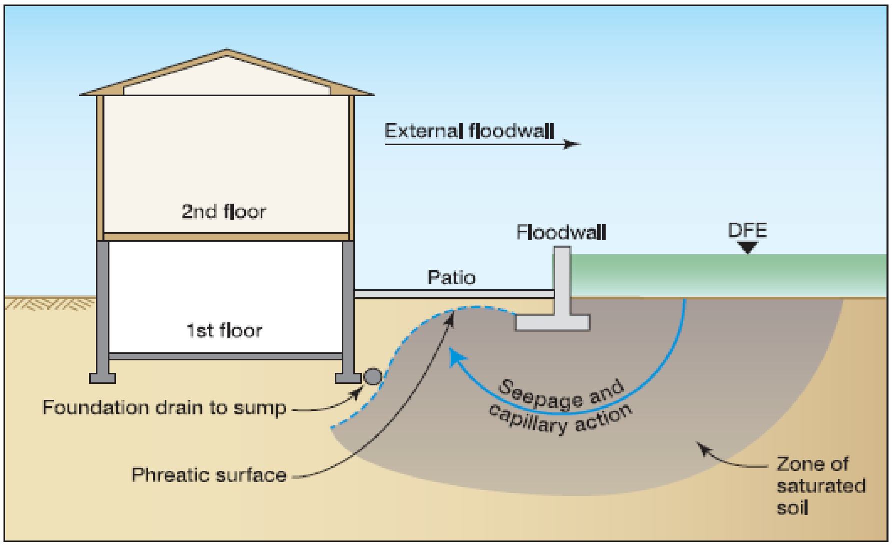
4.2 Construct New Concrete Floodwall with or without Movable Panels

Similar to last section, for locations without flood defense measure and with limited space (Fig. 4.4.1), in regard to long-term protection the construction of a concrete floodwall is preferred. If the field conditions are befitting, this measure should be used for flood defense. As discussed in the above section, if the required height of the concrete floodwall is too high and block the view of the residences, the floodwall may be constructed with moavable or removable flood panels connected on the top of concrete floodwall. They are described as follows.

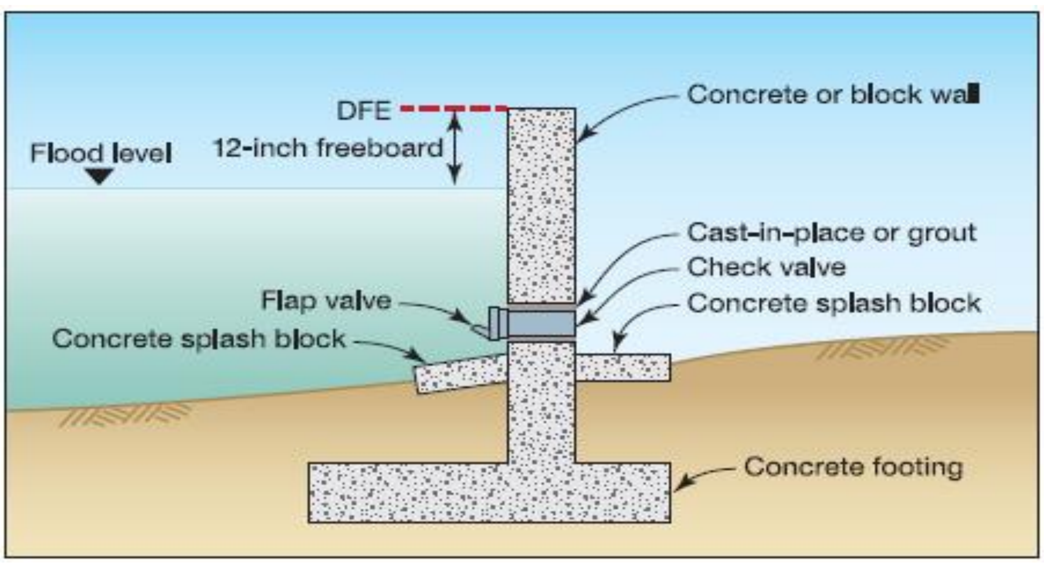
Fig. 4.4.1 Constructing New Concrete Floodwall with or Without Movable Flood Panels

4.2.1 Floodwall without Movable Flood Panels

Fig. 5.4.2 illustrates the floodwall details proposed by FEMA for protecting the residences. For area where it is befitting (e.g., the required floodwall height for various water protection levels can be accepted by the public or others), this type of floodwall should be constructed.



(a) Floodwall without Movable or Removable Flood Panels



(b) Typical Floodwall Details with Check Valve

Fig. 4.4.2 Illustration of Floodwall Details without Movable or Removable Panels
(Sources: http://www.fema.gov/media-library-data/20130726-1506-20490-7472/fema259_ch5f.pdf)

4.2.2 Floodwall Incorporated with Check Valve and Movable Flood Panels

However, in areas where the required height of a floodwall is too high and not acceptable by the public or others, the floodwall should be constructed with moavable or removable flood panels connected on the top of concrete floodwall. In this study, the newly-develped movable flood panels are proposed to be installed on the top of the concrete floodwall (Figs.5.4.3 and 5.4.4). Their working principles are similar to those described in the previous section (Bulkhead with movable flood panels).

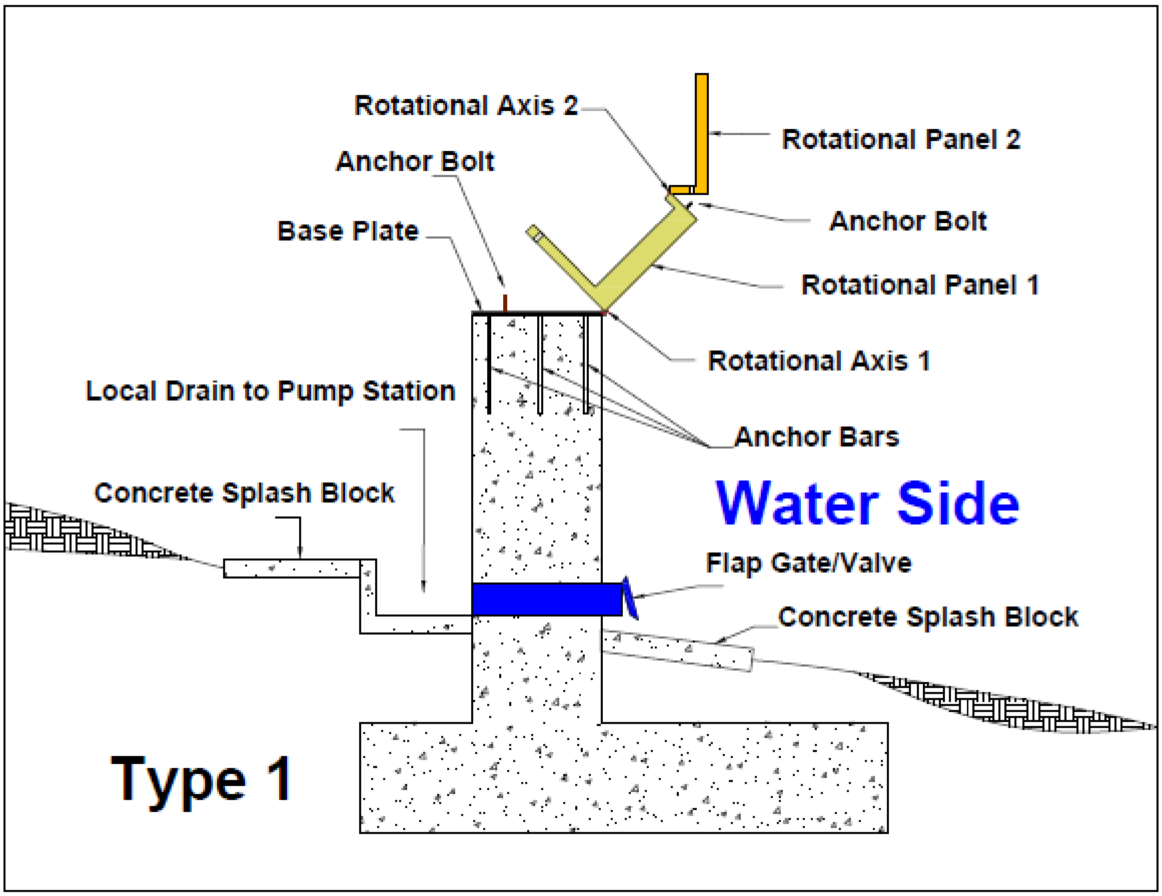


Fig. 4.4.3 Illustration of Concrete Floodwall with Movable or Removable Panels.

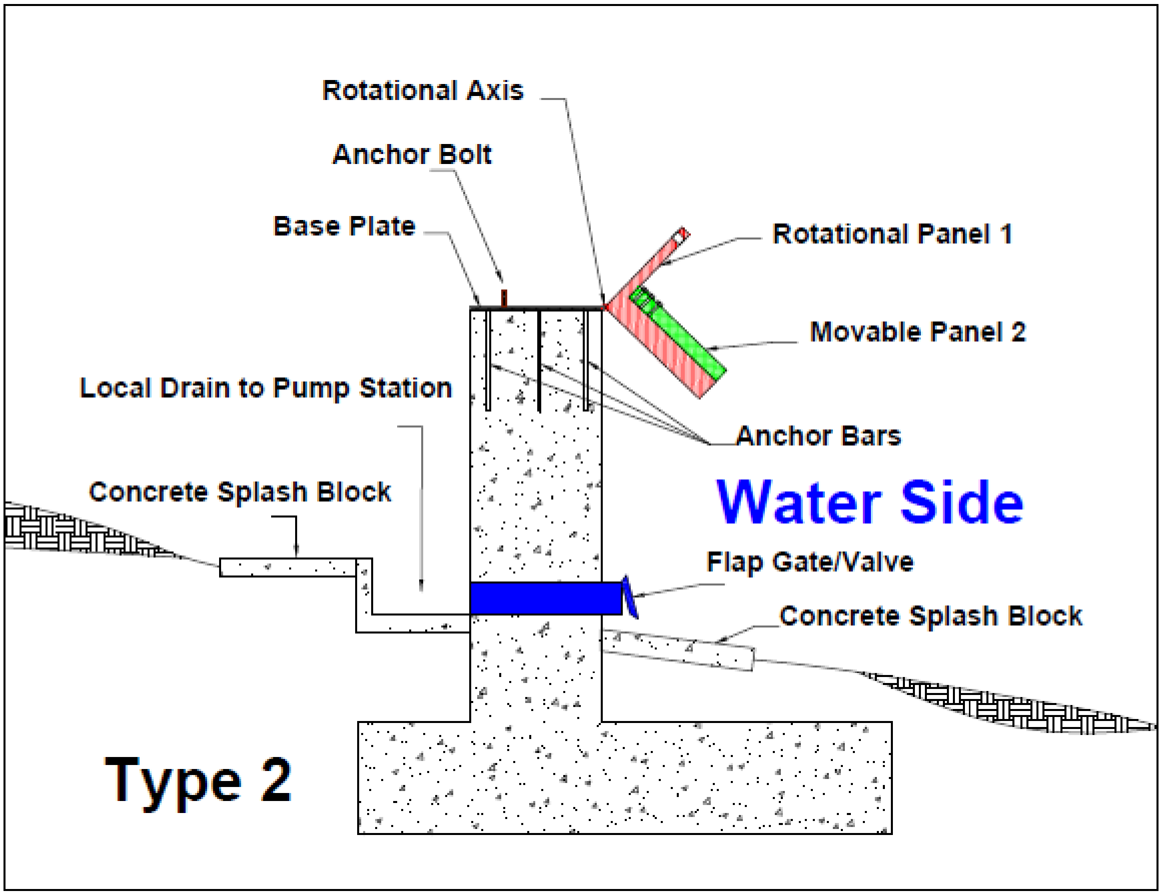


Fig. 4.4.4 Illustration of Concrete Floodwall with Movable or Removable Panels.

4.2.3 Typical Floodwall Closures

When floodwalls are constructed for flood defense, floodwall closures should be used at the accesses or other types of openings. Fig. 4.4.5 shows some typical floodwall closures proposed by FEMA in the reference "Engineering Principles and practices for Retrofitting Flood-Prone Residential Structures".

The other types of existing floodwall closures are provided in Appendix B.

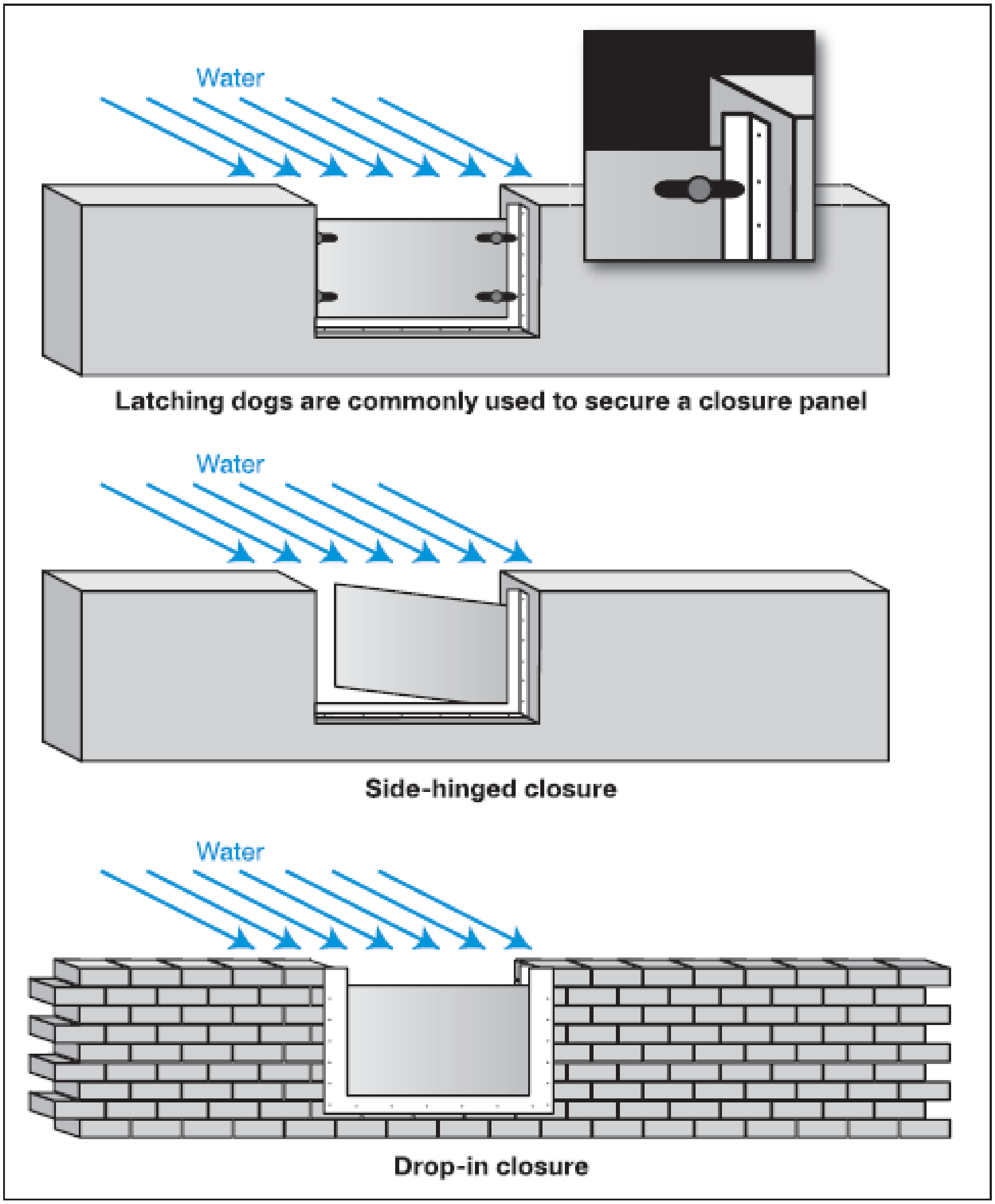


Fig.4.4.5 Typical Floodwall Closures
(Source: http://www.fema.gov/media-library-data/20130726-1506-20490-7472/fema259_ch5f.pdf)

4.3 Increase Existing Bulkhead Height by Adding Movable Panels

For existing bulkheads, the red lines as shown in Fig. 4.5.1 that are too low to satisfy the flood defense requirement at different water protection levels, measures by increasing bulkhead height may be more cost and time effective. In this study, bulkhead height may be increased by the construction of a concrete bulkhead cap with movable flood panels to improve coastal flood mitigation along Barnegat Bay.

The construction method and working principle are similar to that for new metal sheet bulkhead construction as desribed in the previous section on Constructing a New Bulkhead with or without Movable Flood Panels. The only difference is that the concrete bulkhead cap and movable flood panels are to be built. The detailed components of flood defense measures are shown in Figs. 4.5.2 and 4.5.3.

Fig. 4.5.1 Increasing Existing Bulkhead Height With Movable Flood Panels

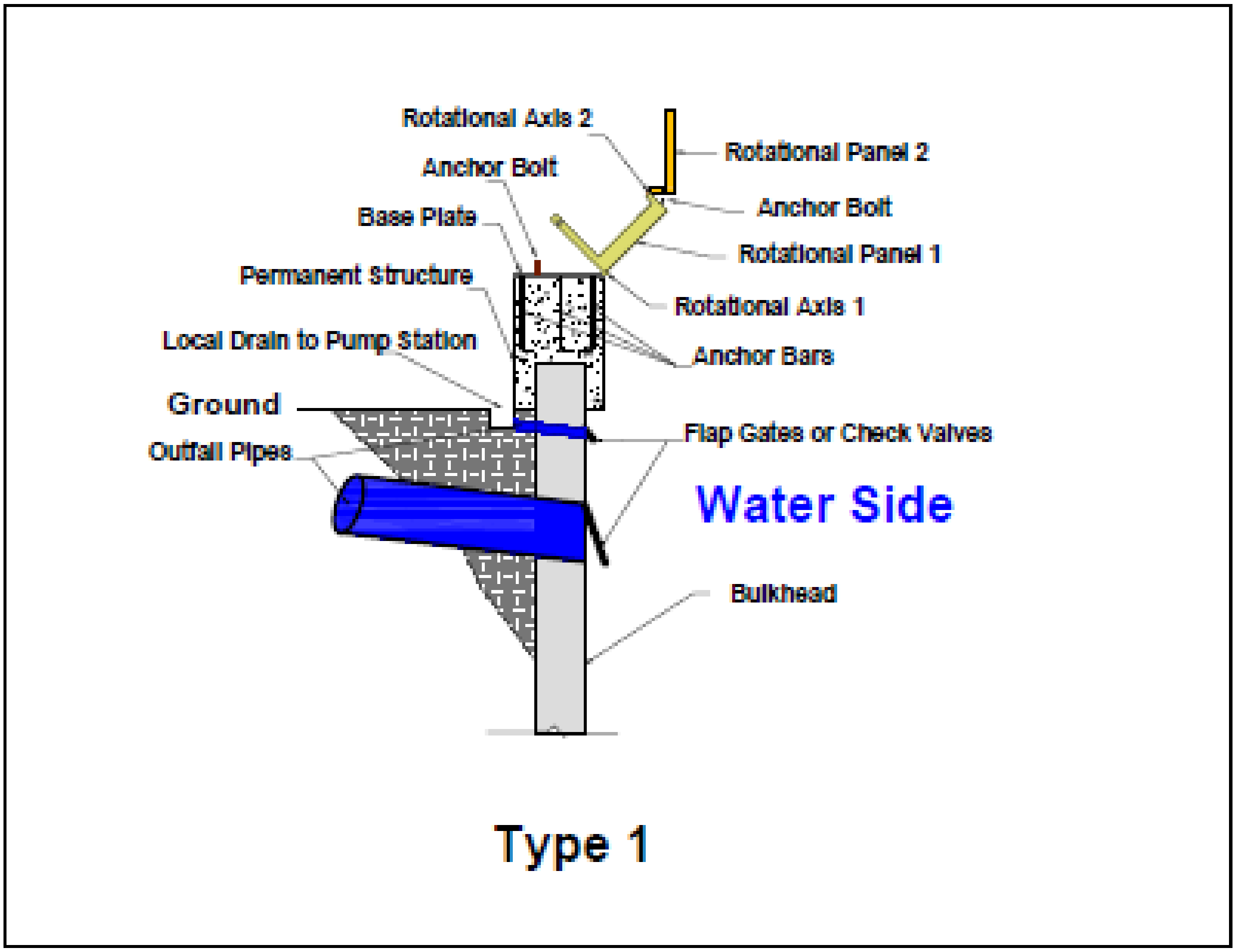


Fig. 4.5.2 Increasing Bulkhead Height with Movable Flood Panel Type 1

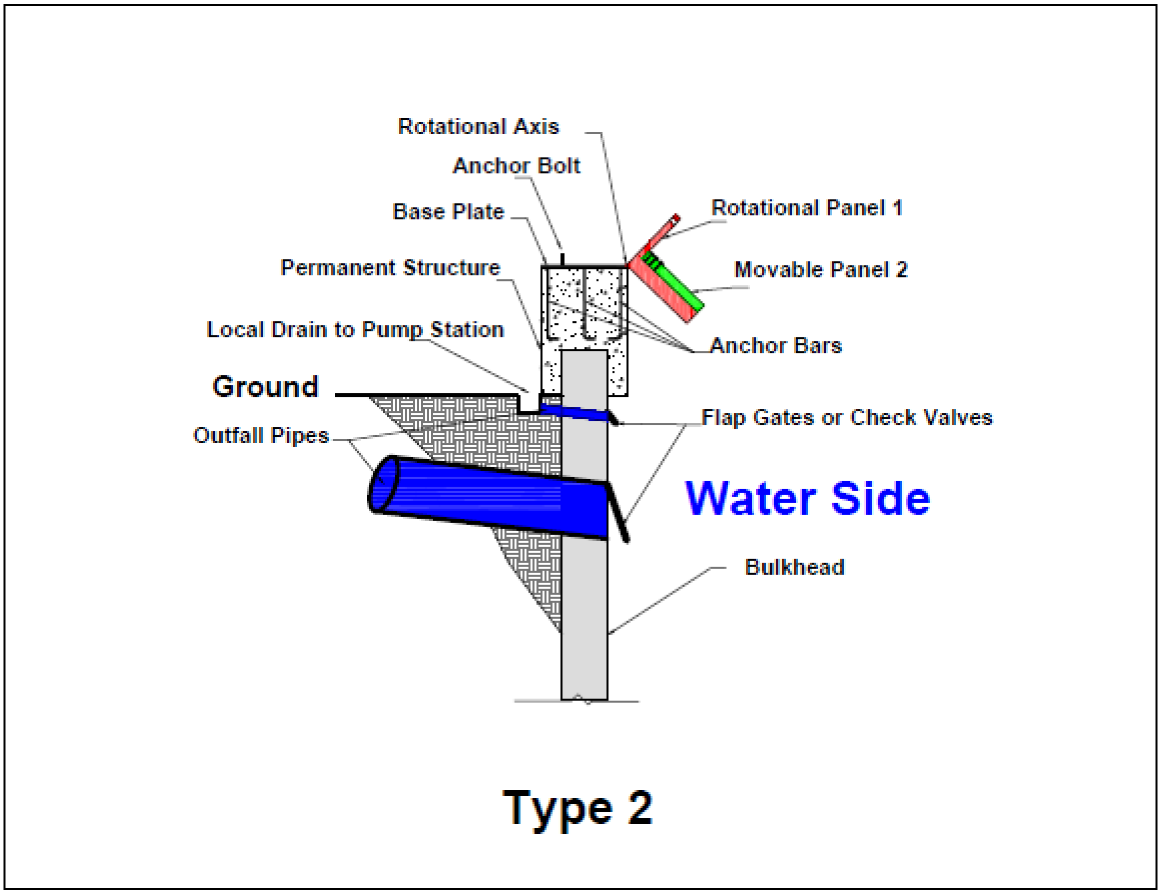


Fig. 4.5.3 Increasing Bulkhead Height with Movable Flood Panel Type 2

4.4 Construct Movable or Removable Flood Panels

For protecting areas along a dock/shipyard, as shown in Figs.4.6.1 and 4.6.2, or vertical river banks with flat and strong surfaces, the movable or removable panels can be used for short-term or long-term flood defense measures.

Fig. 4.6.1 Constructing Movable or Removable Flood Panels to Protect Marina Area

Fig. 4.6.2 Constructing Movable or Removable Flood Panels to Protect Marina Area

In this study, the new developed movable flood panels are proposed for flood denfense measures for locations as described in the above. Figs. 4.6.3 and 4.6.4 illustrate the detailed components of the system and positions of the movable flood panels at different water protection levels for Type 1. The detailed component and panel positions for Type 2 at different water protection levels are shown in Figs. 4.6.5 and 4.6.6, respectively.

Other types of existing movable flood panels are provided in Appendix B.

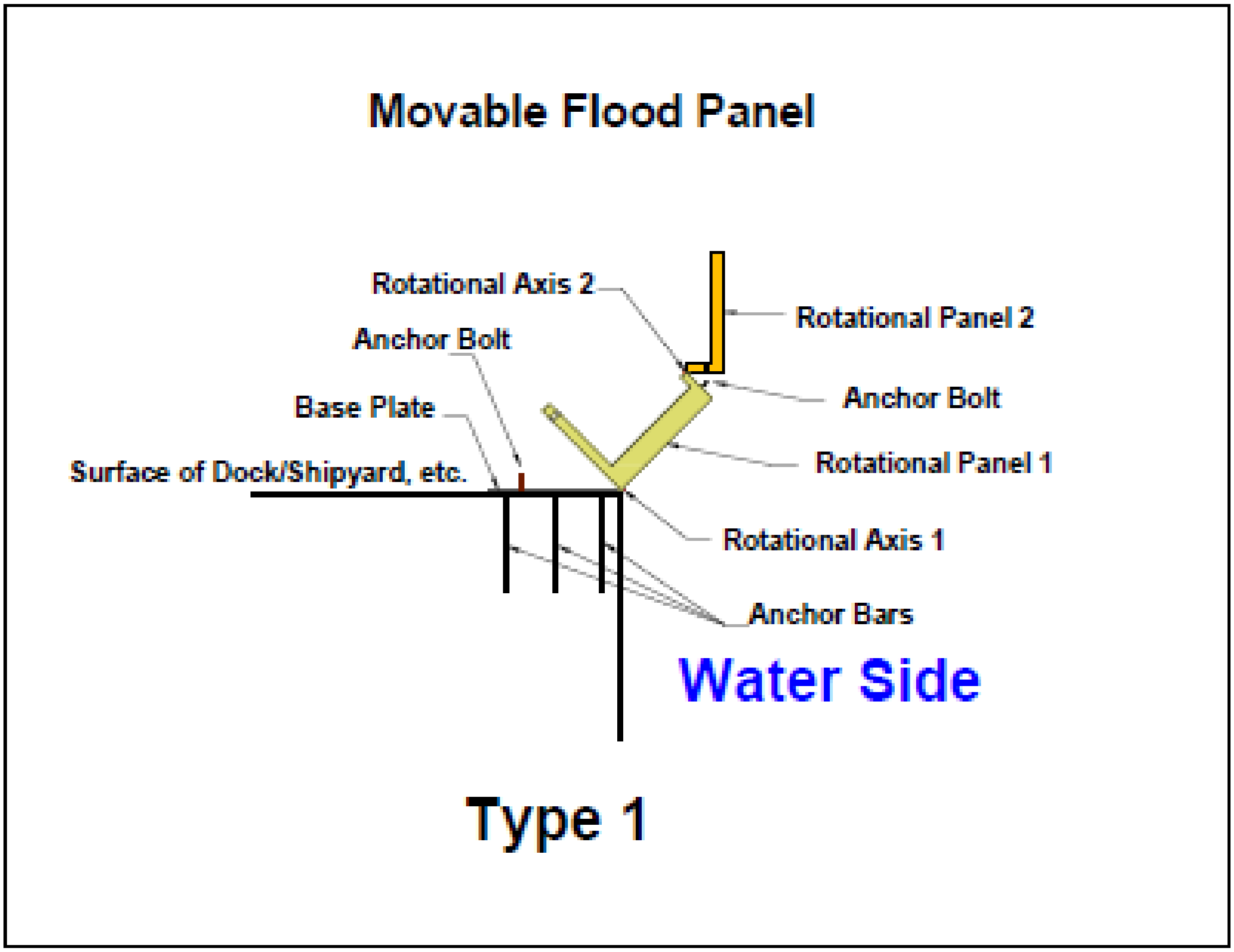


Fig. 4.6.3 Illustration of Movable Flood Panel Type 1

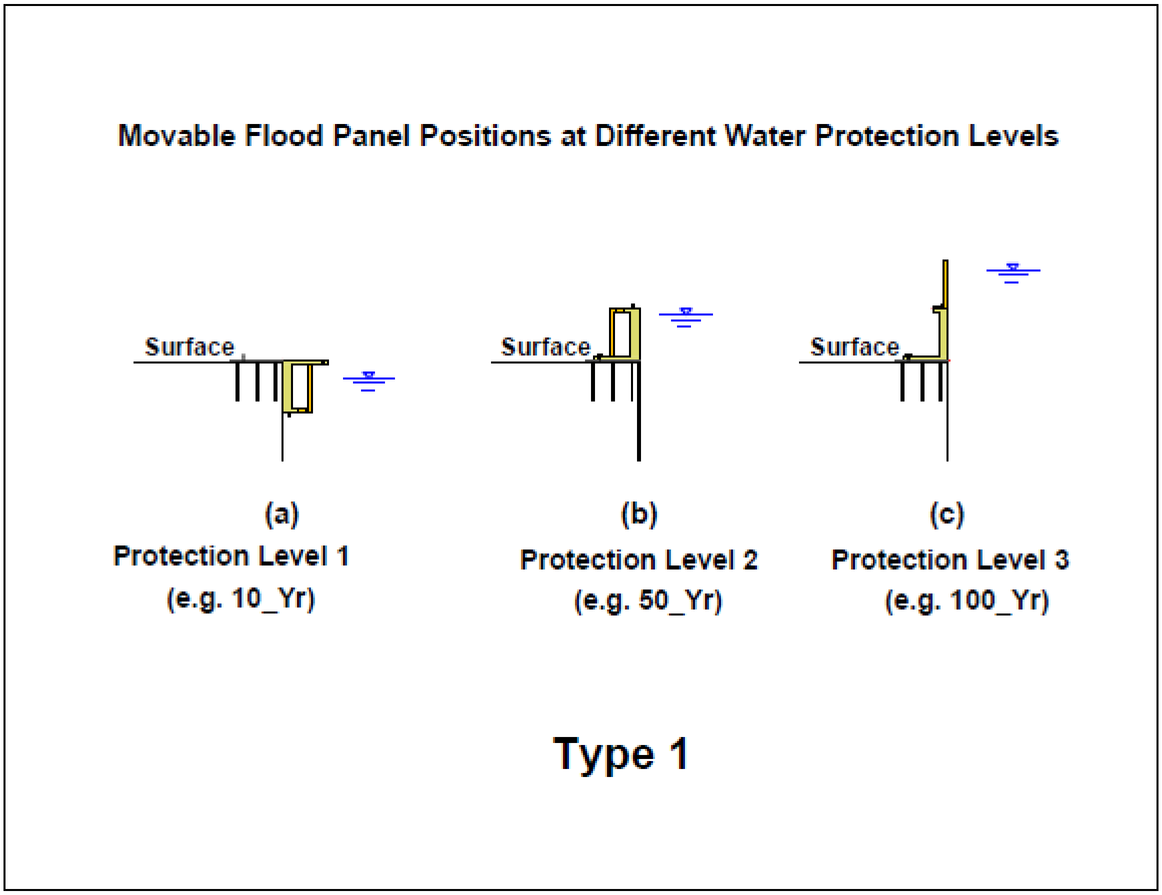


Fig. 4.6.4 Movable Flood Panel Positions for Different Water protection Levels for Type 1

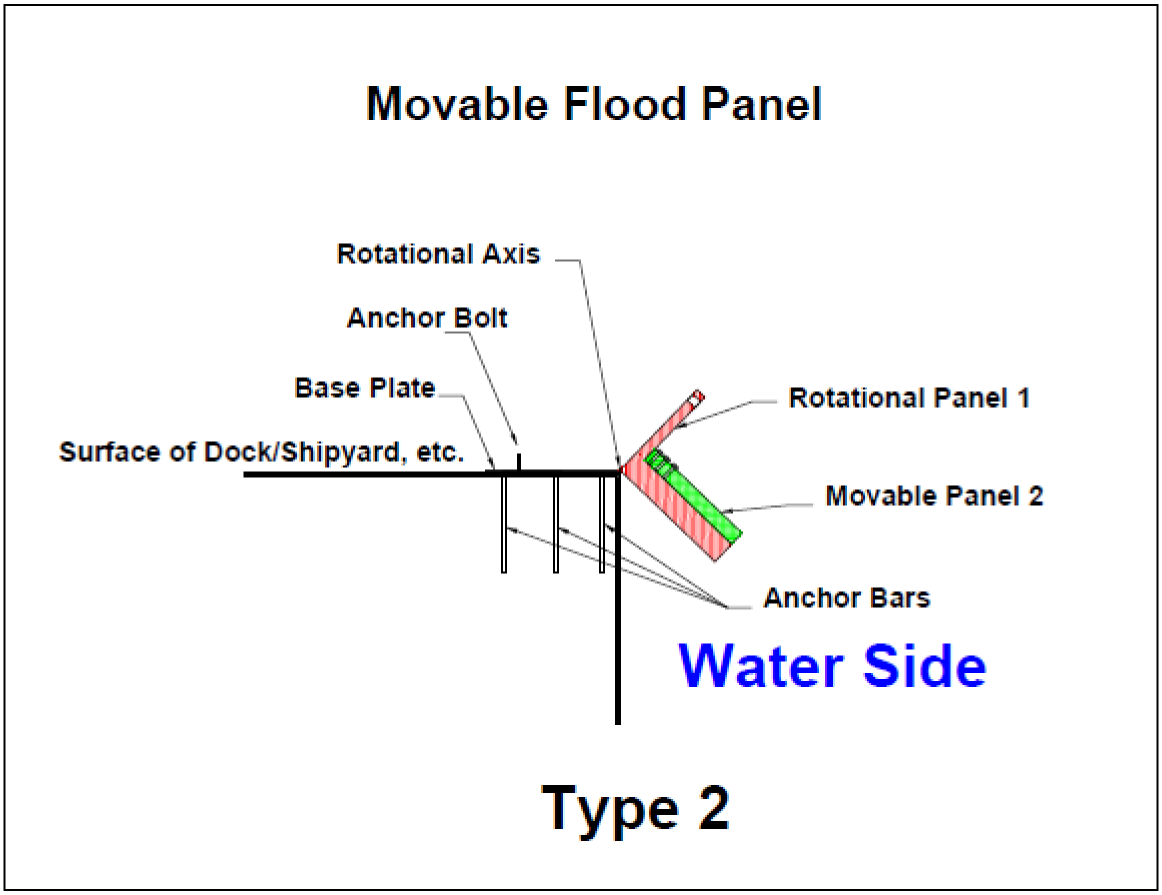


Fig. 4.6.5 Illustration of Movable Flood Panel Type 2

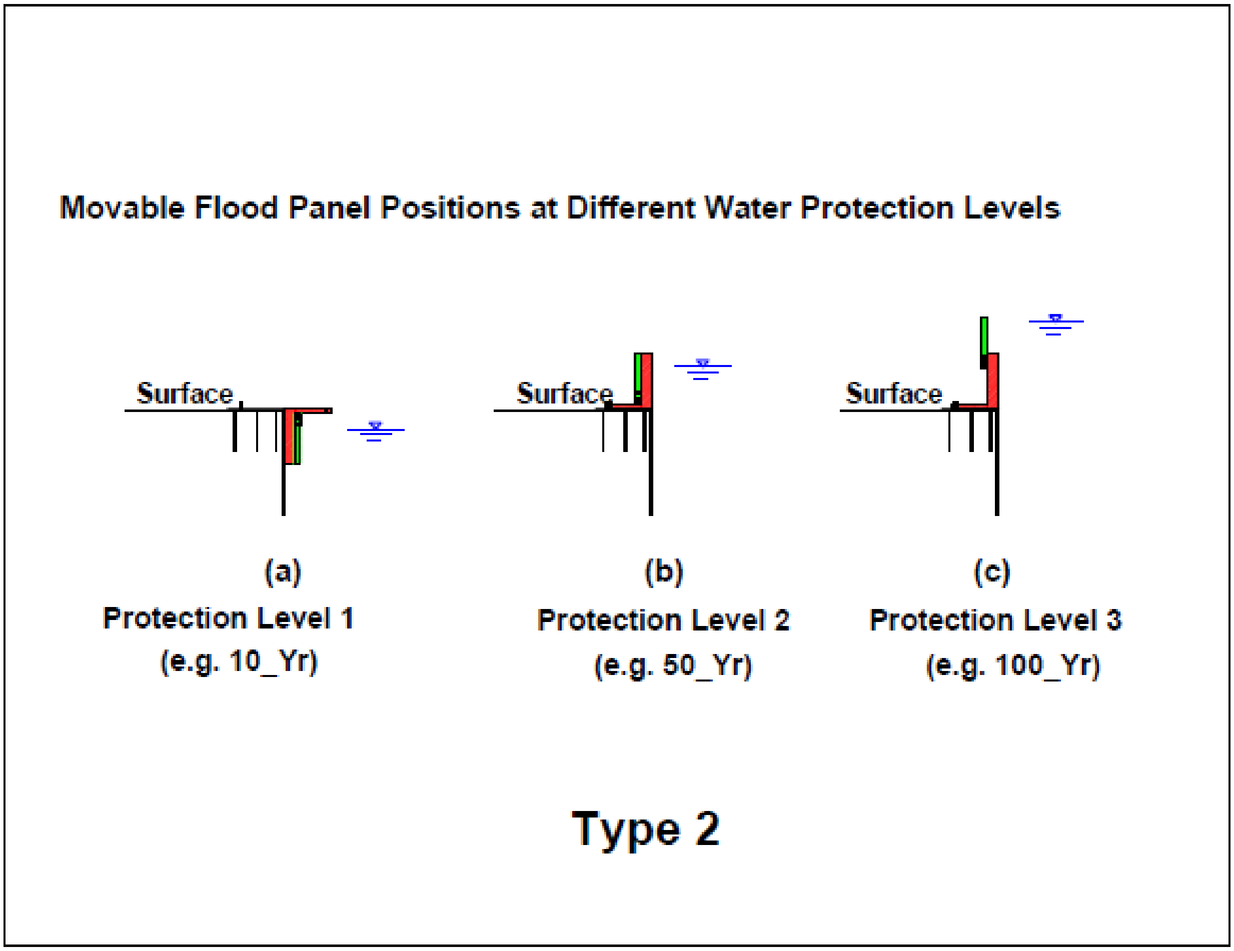


Fig. 4.6.6 Movable Flood Panel Positions for Different Water protection Levels for Type 2

4.5 New Levee Incorporated with Culvert or Pipe and Flap Gate/Check Valve

The earthen levees are often used in areas where the protected properties are bordering or near designated green space. The earthen levee surface must be covered by planting grass to prevent erosion. For field conditions as shown in Figs.4.7.1 and 4.7.2, constructing an earthen levee for flood risk mitigation may be more cost and time effective, and easy to remove or retrofit for future land development. If the tributary waterways are blocked by the levee, culverts with flap gates and fish ladders should be incorporated in the construction.

One of the typical section details and drain pipe layouts for a residential levee which proposed by FEMA in the reference "Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures" is illustrated in Figs. 4.7.3 and 4.7.4. For detailed design and construction, the levee design manual should be followed. Other typical sections with drainage structures through levees and closure devices proposed by the Army Corps of Engineers are shown in Figs. 4.7.5 and 4.7.6.

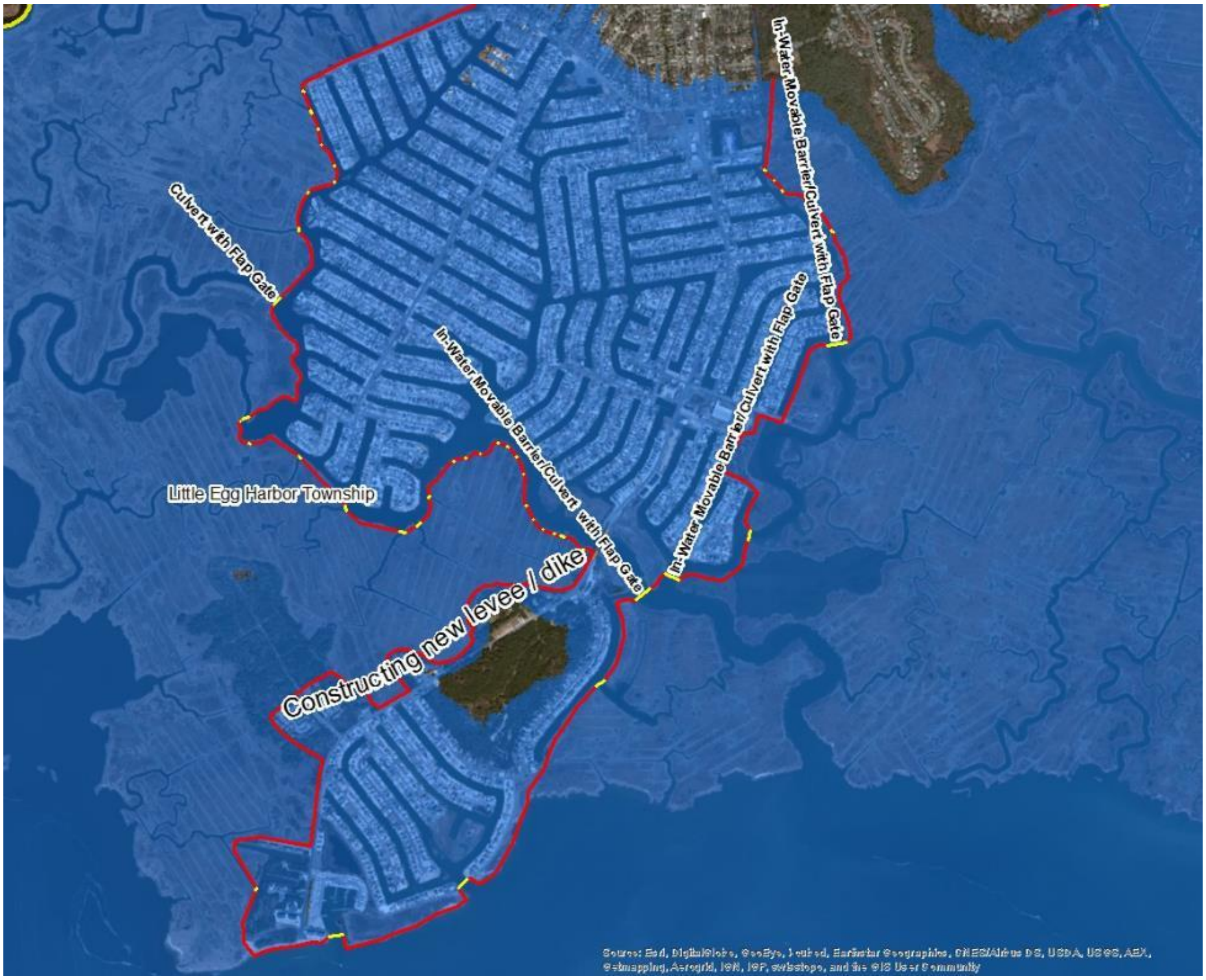


Fig.4.7.1 Constructing a New Levee and Curvert with Flap Gate or Sluice Gate

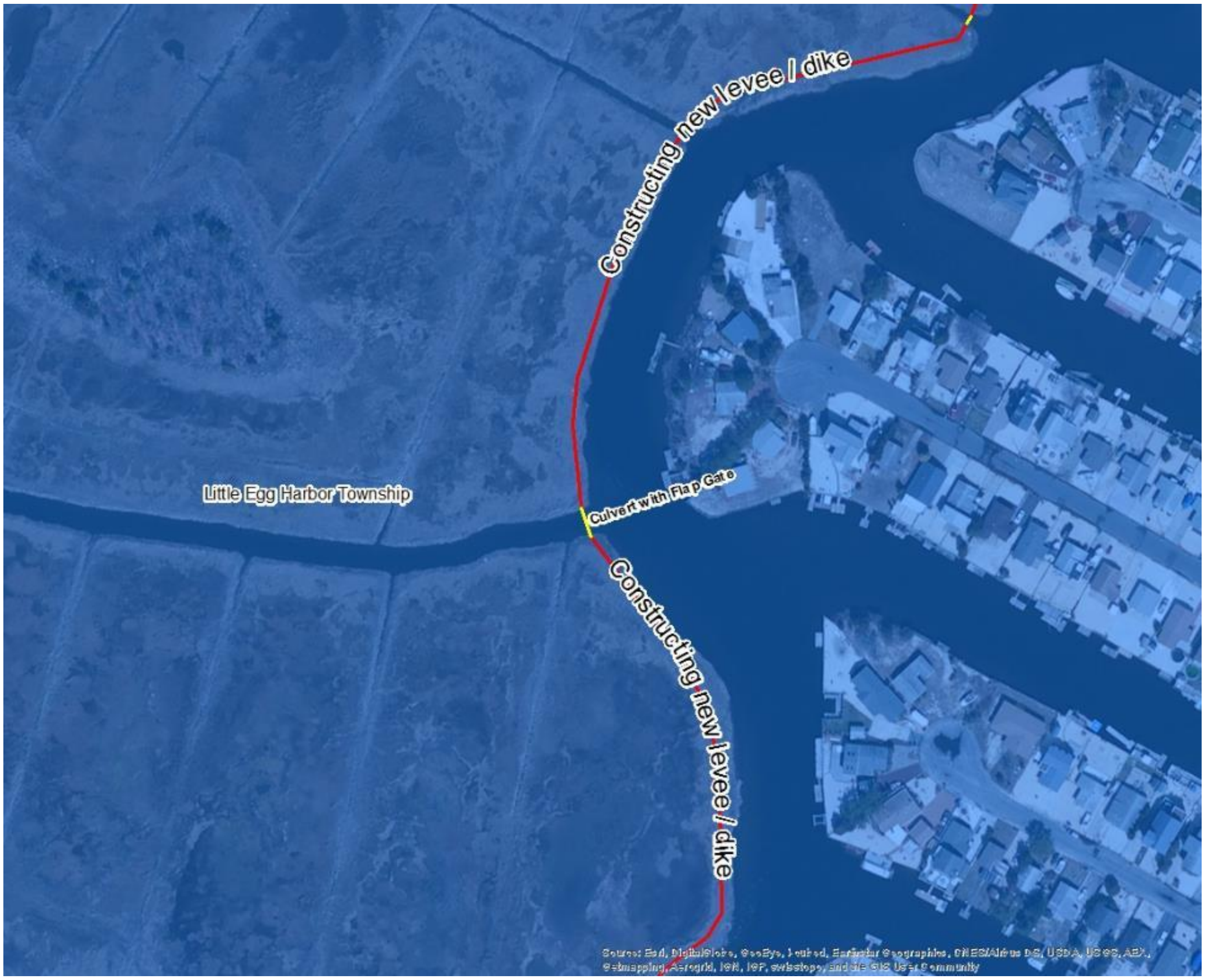


Fig.4.7.2 Constructing a New Levee and Culvert with Flap Gate

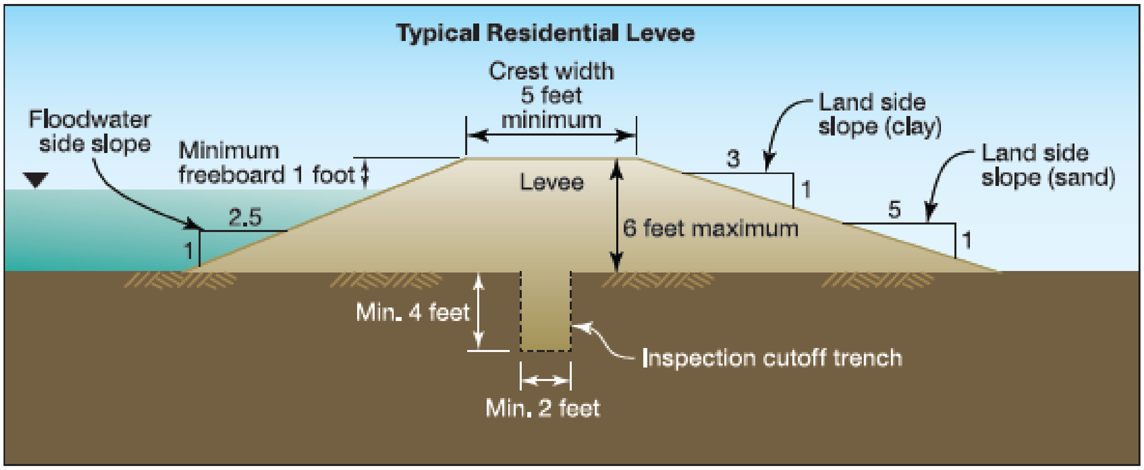


Fig.4.7.3 Typical Section for a Residential Levee
(Sources: http://www.fema.gov/media-library-data/20130726-1506-20490-7472/fema259_ch5f.pdf)

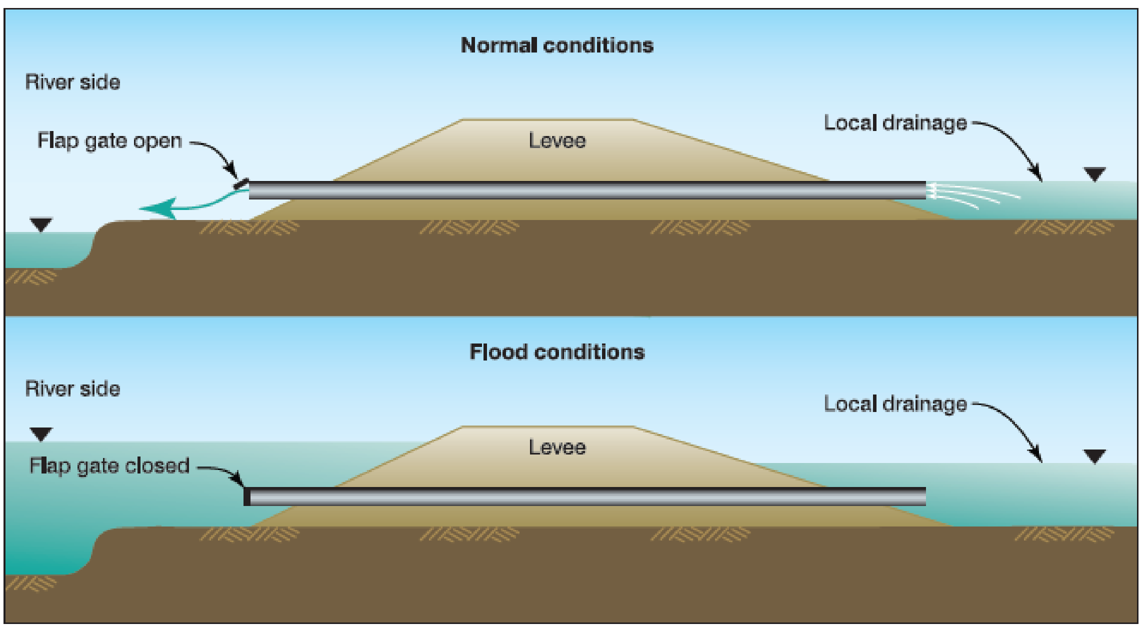


Fig.4.7.4 Sketch of a Drain Pipe Extending through a Levee
(Sources: http://www.fema.gov/media-library-data/20130726-1506-20490-7472/fema259_ch5f.pdf)

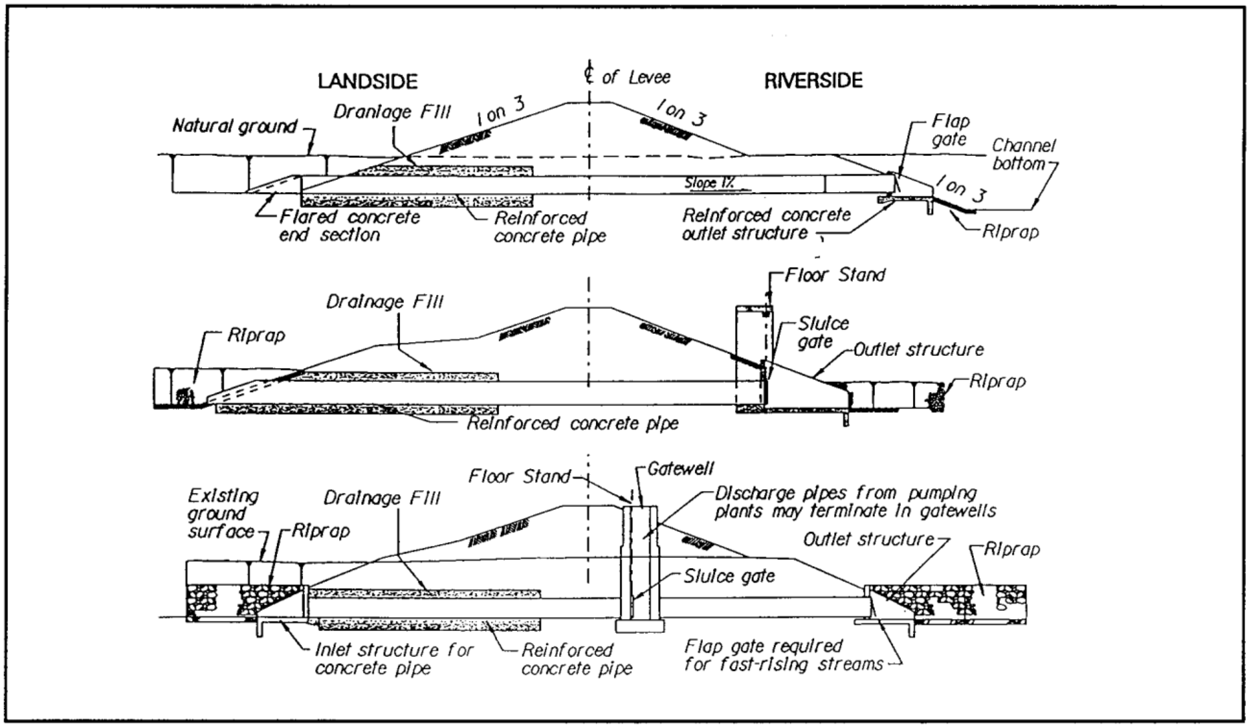


Fig.4.7.5 Typical Sections and Drainage Structures through Levees (Source: USACE, 2000)

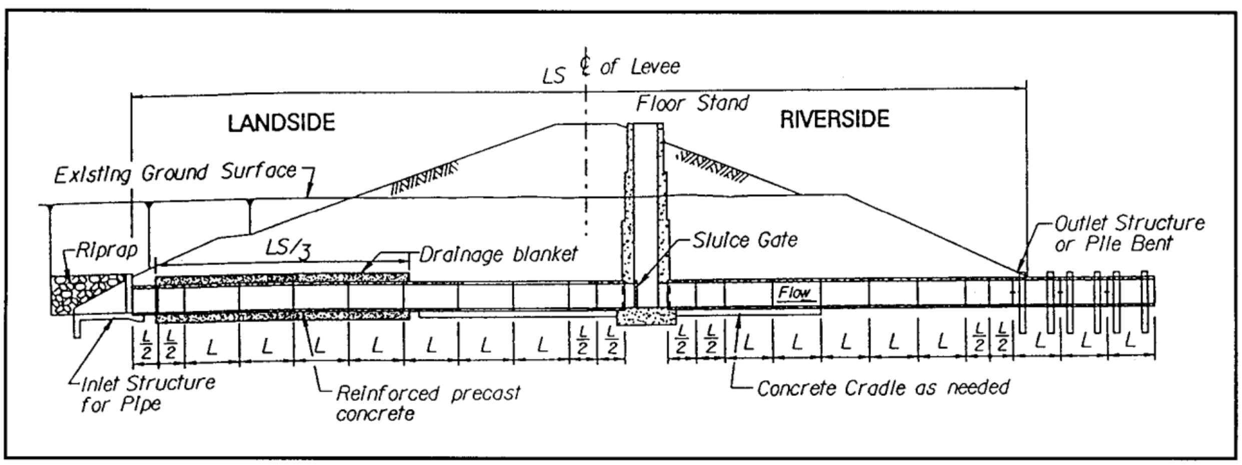


Fig. 4.7.6 Closure Device for Typical Precast Conduit (Source: USACE, 2000)

4.6 Elevate Residences

In areas where only a few residences are under flood threat (Fig.4.8.1), or areas with low density of residences (Fig.4.8.2), elevating the residences may be more cost and time effective than other alternatives. Fig. 4.8.3 shows an example of elevating a residence at Seaside Height Borough.

Fig. 4.8.1 Elevating Residences Located at Low-lying Area

Fig. 4.8.2 Elevating the Low Density Residences

Fig.4.8.3 Elevating a Residence in Progress at Seaside Heights Borough, NJ

4.7 Raise the Roadway

If the roadway is along the water body as shown in Fig. 4.9.1, raising the roadway may be a good alternative. The raised roadway with proper side protection can function as levee. Based on analysis by considering various factors, if possible, this measure should be used.

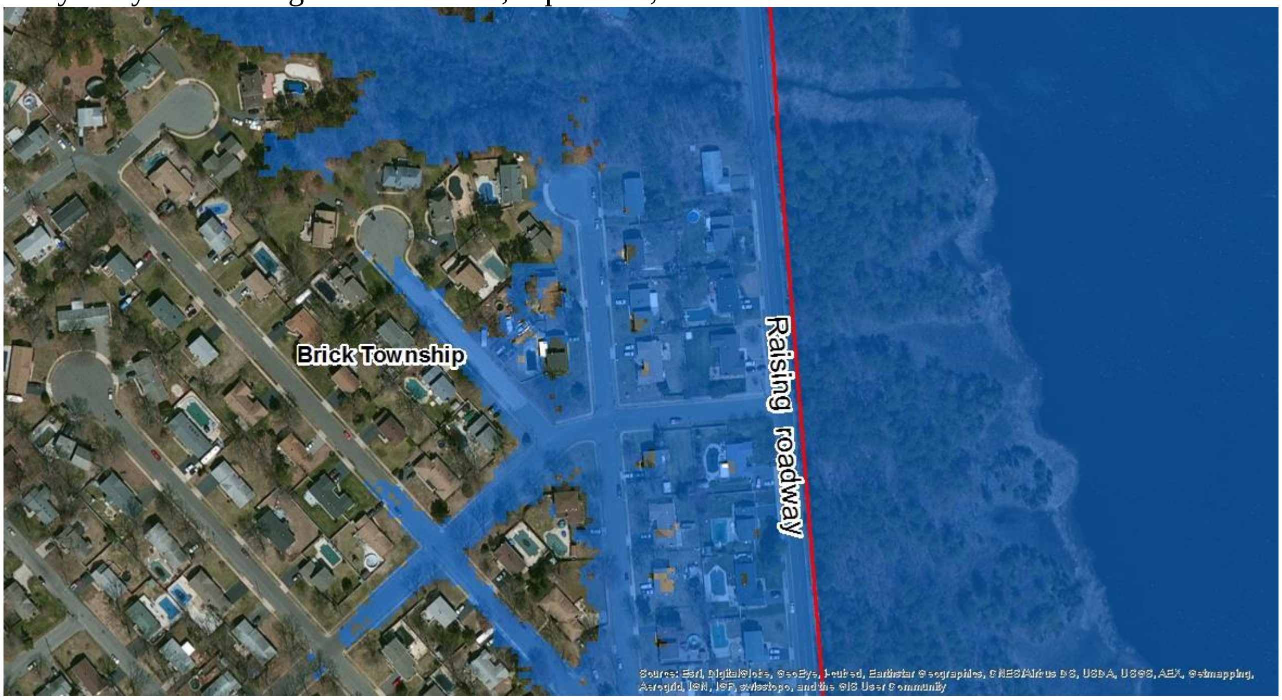


Fig.4.9.1 Raising the Roadway

4.8 Construct Sluice Gate or In-water Barrier

After constructing flood defense measures along dredged lagoon areas, a sluice gate or in-water barrier should be installed at the lagoon ends to prevent the storm surge entering the lagoons (Fig.4.10.1). The sluice gate or in-water barrier should be closed prior to a storm event; whereas after the flood water recedes, the sluice gate or in-water barrier may be openned for water exchange and shipping activities.

Two types of gates: a radial gate and a sluice gate manufactured by Golden Harvest, Inc. are shown in Figs. 4.10.1 and 4.10.2. In terms of the field conditions at Barnegat Bay, the radial type may be preferred.

Fig. 4.10.1 Constructing Sluice Gate or In-water Barrier at Lagoon Ends: (1) Yellow line represents Sluice Gate or In-water Barrier, (2) Red line represents bulkhead with or without movable flood panels.

Fig. 4.10.2 Radial Gate (Source: Golden Harvest, Inc.)
(http://www.goldenharvestinc.com/products/)

Fig. 4.10.3 Heavy Duty Sluice Gate (Source: Golden Harvest, Inc.)
(Source: http://www.goldenharvestinc.com/products/)

4.9 Construct Flood Gates

After constructing the defense measures along the protected areas as shown in Figs. 4.11.1 and 4.11.2, to prevent the flood water entering the closed area, the flood gates should installed across the roadways to close the openings. Fig. 4.11.3 shows a heavy flood gate used to close the openning to protect the residences prior to a storm event. For Barnegat Bay areas, this scale of flood gate should be used becase the flood defense structures should be strong enough to resist the impact force from the storm surge and waves.

Fig. 4.11.4 shows one type of automatic flood gate developed by FloodBreak. This kind of flood gate is more cost and time effective for inland flood defense. The other types of flood gates are provided in Appendix B.

Fig. 4.11.1 Constructing a Flood Gate to Protect the Closed Area: (1) Yellow line represents flood gate, (2) Red line represents bulkhead or levee.

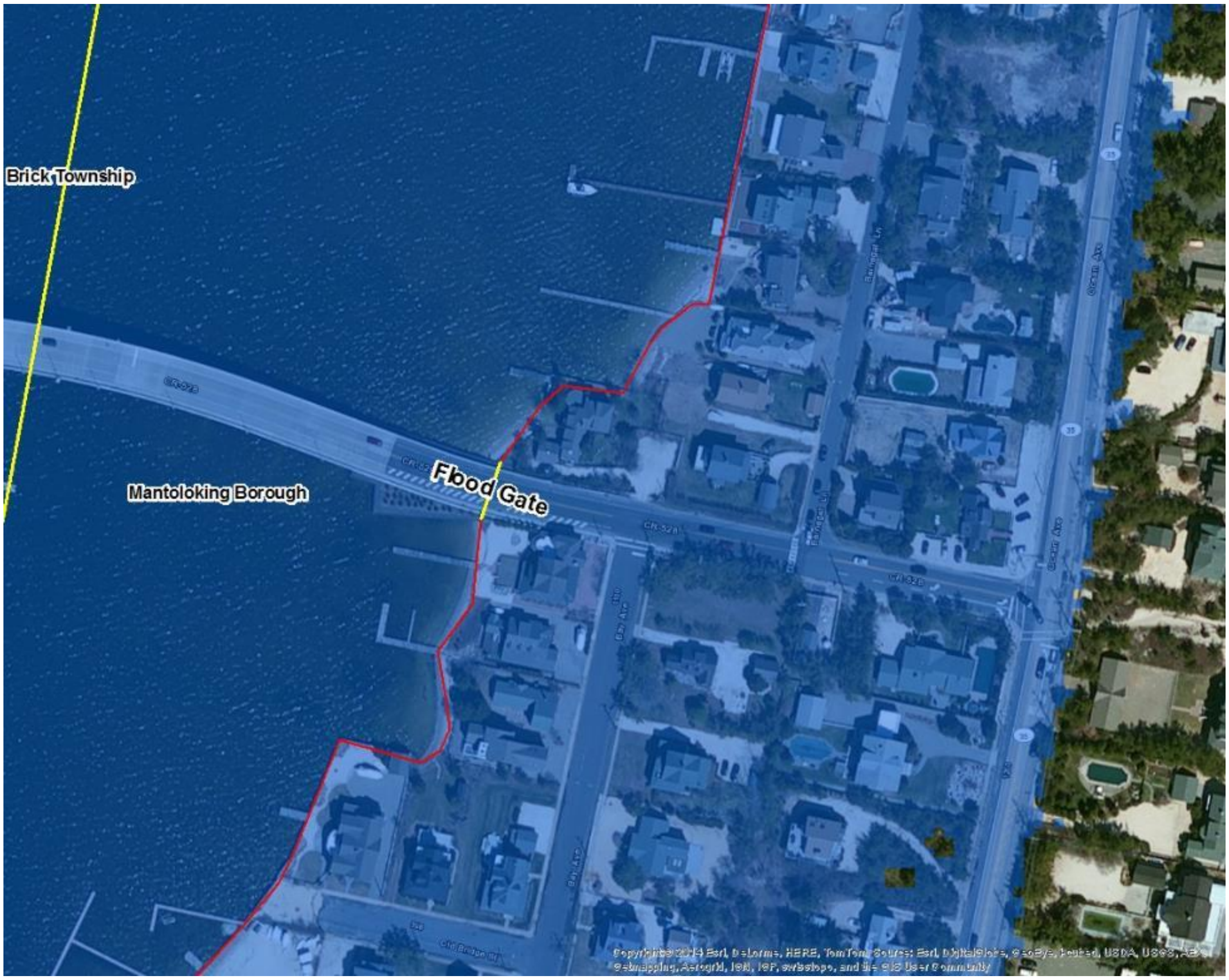


Fig. 4.11.2 Constructing a Flood Gate to Close the Opening

Fig. 4.11.3 Flood Gate to Closing the Opening

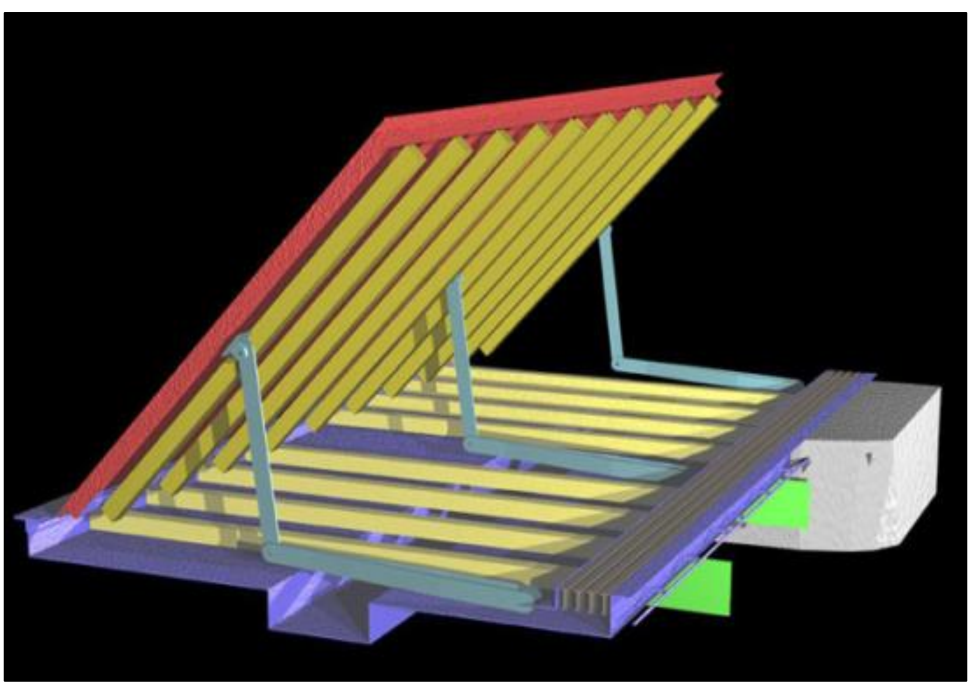


Fig. 4.11.4 Sketch of FloodBreak (R) Automatic Floodgates
(Source: http://floodbreak.com/contact-us/)

4.10 Construct Pump Stations

For low-lying areas or areas with flood defense measures such as floodwalls or levees, when the waterway water levels are higher than the inland flood water levels, the inland flood water cannot be drained out by gravitational forcing during the flood period. Under this situation, pumping stations are used to pump the inland flood waters into rivers or bays. Fig.4.12.1 shows a sketch of pumping station located beside an earthen levee and driven by electric power.

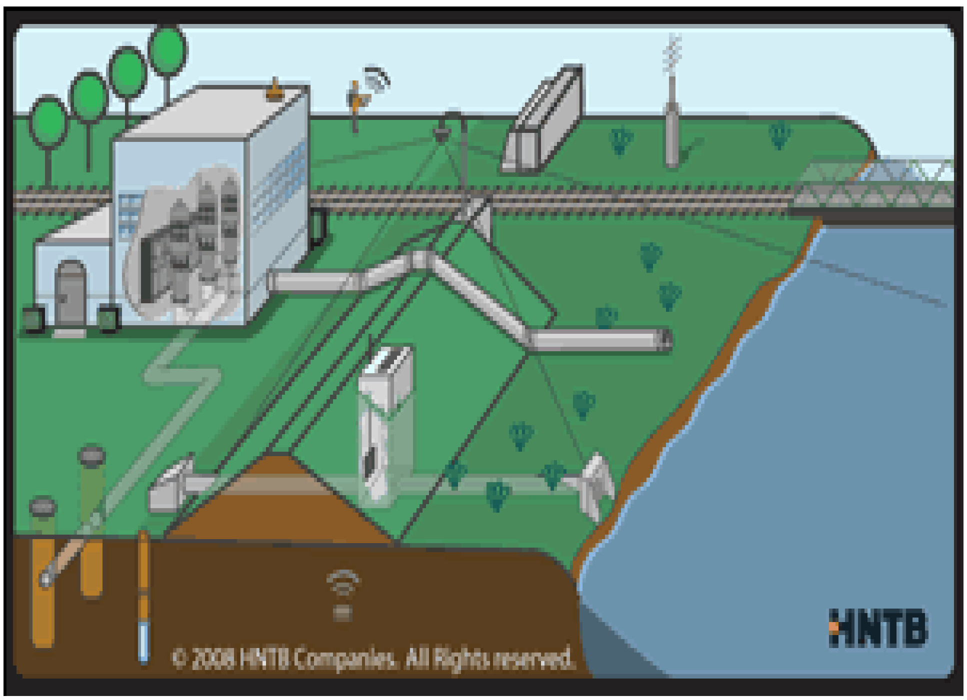


Fig. 4.12.1 Sketch of Pumping Station Located Beside an Earthen Levee (Source:http://library.water-resources.us/docs/MMDL/FLD/Feature.cfm?ID=16)

However, under extreme weather conditions (e.g., Superstorm Sandy), the power supply systems may be seriously damaged, and the pumping stations may not work. To help solve this problem, six new types of pumps driven by green energies are conceptually designed, and they are described in the next section (V).

The placement of pump stations, based on the rainfall design frequency, is provided in Section VI.

4.11 Add Bypass Force Mains for Elevated Areas to Improve Stormwater Drainage

Roofs of the building (the roofs) are typical at a much higher elevation than that of the downstream water body. Also, a part of the ground surface in the urban area may have an elevation much higher than that of the downstream water body. However, the ground surface immediately adjacent to the water body may be low relative to the water surface, and the storm sewer outfalls maybe partially or fully submerged causing the water draining capacity of the storm sewers to be reduced and the stormwater to back up, leading to the drainage-related flooding problem. In this case, a bypass force main can be utilized for stormwater drainage improvement.

Fig. 4.13.1 illustrates the methodology and components of a bypass force main system for an elevated area for stormwater drainage improvement. The rainwater will be collected from roofs and stored in the containers at relatively high elevations, and then drains into the receiving water directly through the force mains. Similarly, the overland flow (runoff) may also be collected in ponds located at relatively high elevations, and drains into the receiving water directly through the force mains. This method will reduce the flood water accumulation in the developed low-lying areas by directly draining the flood water from the upland into the receiving water.

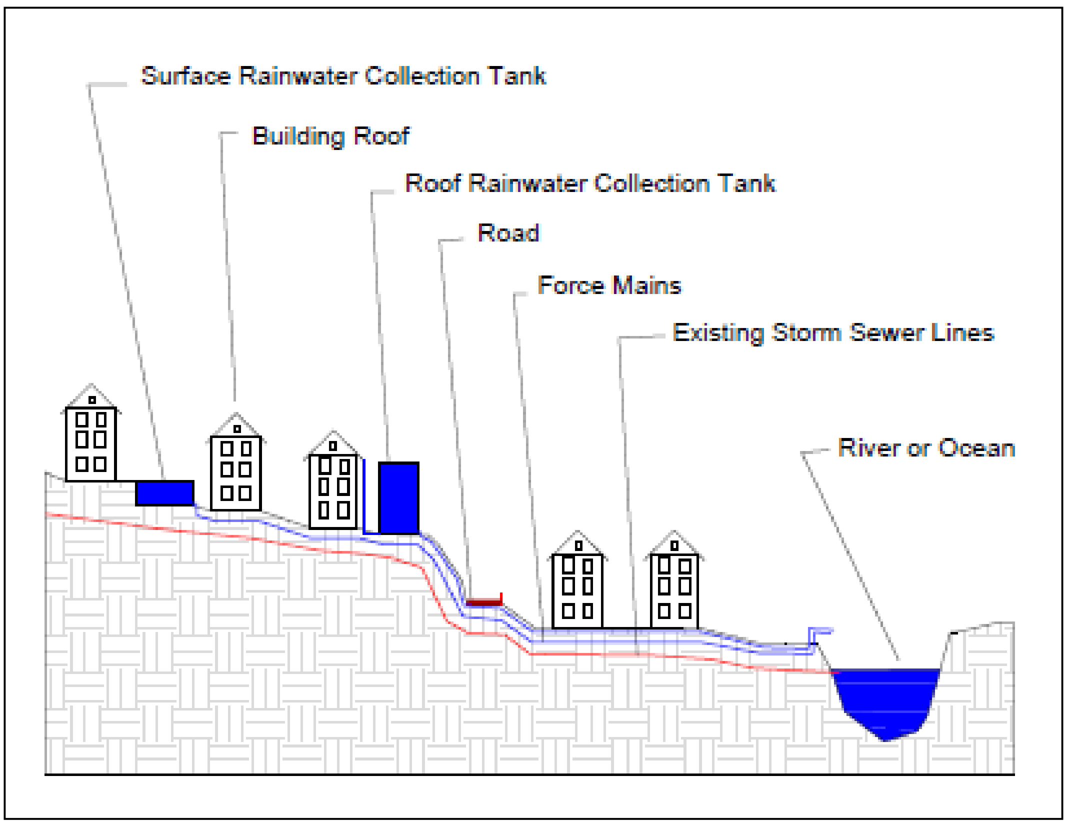


Fig. 4.13.1 Illustrative Sketch of Bypass Force Mains for Elevated Areas to Improve Stormwater Drainage

The two separate lines are illustrated in Figure 4.13.1, one for the existing gravity storm sewer, and another for the added pressurized pipeline (the force main). The added force main could be inserted inside the existing gravity storm sewer to reduce the construction cost.

4.12 Other Proposed Measures

Major surge barriers at the bay inlets (i.e., Barnegat Inlet, Manasquan Inlet, and Little Egg Harbor Inlet) have been contemplated. The effectiveness of these major surge barriers on reducing the back-bay flooding level will be addressed in a concurrent study conducted by Stevens Institute of Technology.

Restoration of salt marsh restoration has also been contemplated for some parts of the bay. The effectiveness of salt marsh restoration inside Barnegat Bay on reducing the back-bay flooding level will be addressed in a concurrent study conducted by the Richard Stockton College of New Jersey.

In addition, the environmental impacts of the proposed solutions will be evaluated in a study conducted by New Jersey Institute of Technology.

V NEW DEVELOPMENT OF GREEN PUMPS

During extreme weather conditions, such as Superstorm Sandy, the power supply systems may be seriously damaged, and the pumping stations dependent on external sources of energy may not work. Therefore, to solve this problem, six new types of pumps driven by green energies are developed in this study. They are:

1) Rainwater Driven Pump
2) Wave/Surge Driven Pump
3) Wind Driven Pump
4) Rainwater Driven Venturi Pump
5) River Flow Driven Venturi Pump
6) Wind Driven Venturi Pump

These technologies are especially useful for inland flood defense during the heavy rainfall events. The energies used to drive these pumps are: (1) potential energy generated by collecting rainwater from uplands and storing it on the uplands, (2) wave or surge energy, and (3) wind energy.

Based on the effective verification by lab and pilot tests, these technologies, in cooperation with various flood defense measures such as flood walls / seawalls, can be employed for flood defense in both inland and coastal areas. The following portion of the report describes the preliminary designs of the newly-developed pumps for flood defense.

5.1 Rainwater Driven Pump

The conceptual sketch of the developed pump driven by rainwater consists of a turbine at top and a pump at bottom, both connected by a common shaft (Fig. 5.1.1). This technology utilizes the potential energy generated by collecting rainwater and storing it at higher elevations to pump the flood water in those areas where the gravity drain systems are not working (i.e., the water level of flooded areas is lower than that of the receiving water, such as rivers or other waterways). Water is guided into a turbine through an inlet pipe to drive the turbine and operate the pump. The water that drives the turbine and the pumped water flows through outlets into the river or other waterway.

Fig. 5.1.2 illustrates the topographic requirement and system placement for this technology. For field conditions with great changes in elevations (i.e., with high net water pressure head across the pump system), this technology works well, and it is applicable for inland flood defense. The driven rainwater can be collected from roofs and stored in the high containers. Further, overland flow may also be collected in ponds located at higher elevations. In addition to saving energy, this method also reduces the flood water accumulation in the developed areas by directly draining the flood water from the upland into the receiving water.

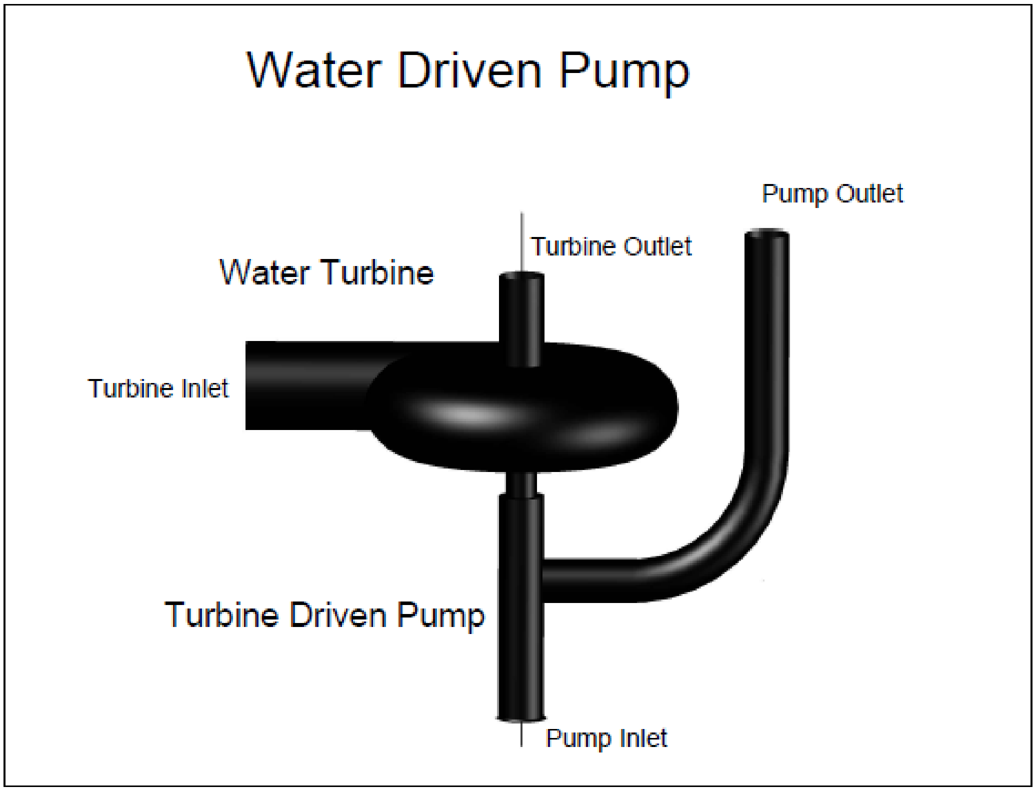


Fig. 5.1.1 Conceptual Sketch of Rainwater Driven Pump

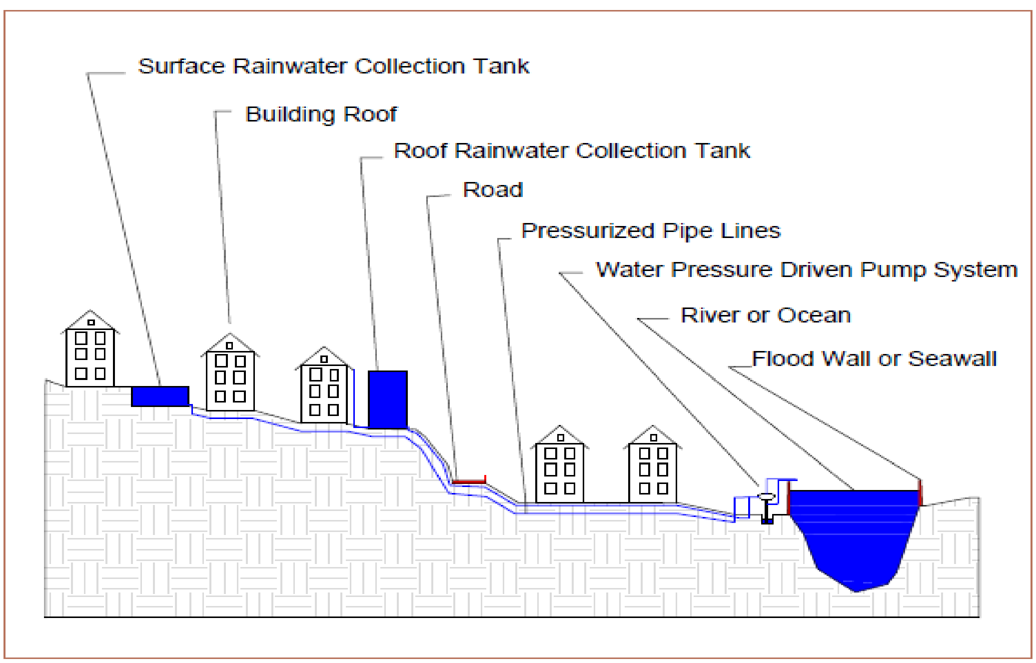


Fig. 5.1.2 System Illustration of Rainwater Driven Pump Application

5.2 Wave Driven Pump

This technology is developed to pump the inland flood water along coastal areas. The pump consists of a box with springs fixed inside and perpendicular to the wall face (Fig. 5.2.1). The box expands to hold flood water. It has an inlet pipe with a valve to transfer the flood water into the box, and an outlet pipe with a valve to drain flood water from the box into the ocean or bay.

The pumps are installed on the ocean or bay side of a seawall or flood wall. When the wave or surge moves towards the pump, an impulse force will be exerted on the pump box causing the inlet valve to close, and the box to compress pushing the collected water to be forcibly expelled. However, when the oscillatory wave or surge moves away from the pump box, the valve at the outlet opening will close and the box will expand, causing the inlet valve to open and to pull flood water into the box for next draining cycle. The views of inland side, ocean side and top for the 4-unit pump group are shown in Fig. 5.2.2, 5.2.3 and 5.2.4.

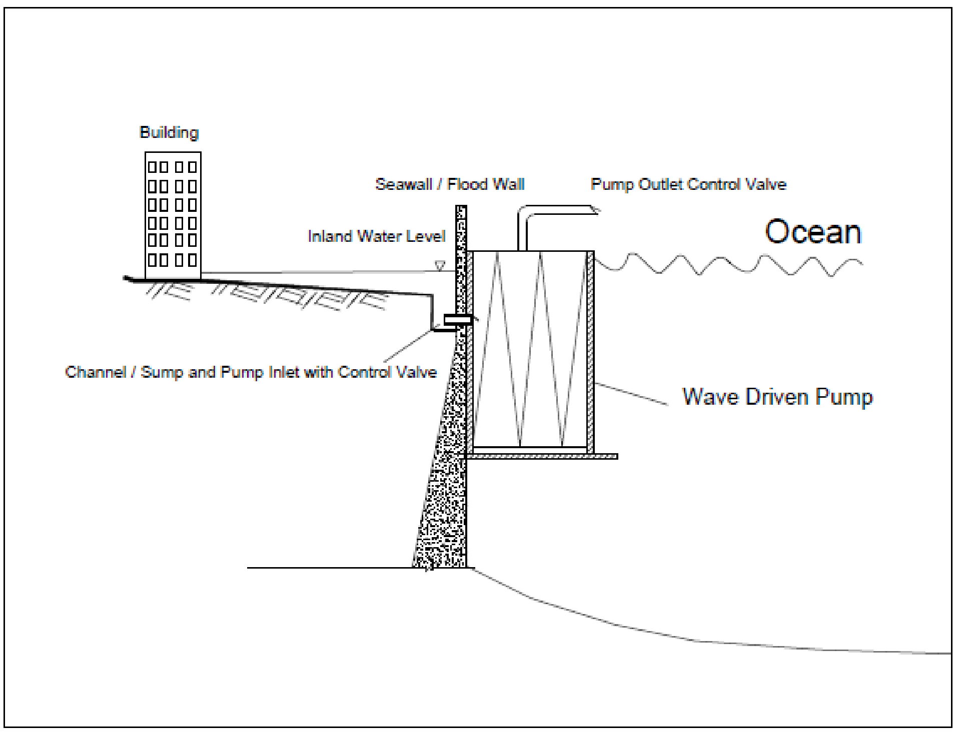


Fig.5.2.1 System Illustration of Wave Driven Pump Application

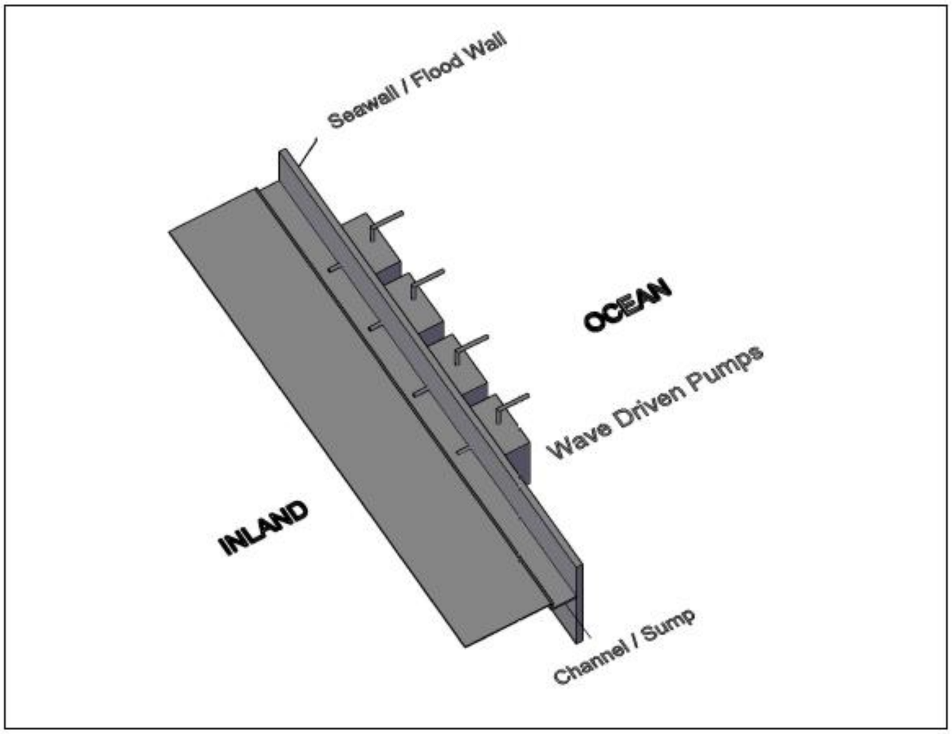


Fig.5.2.2 Inland Side View of 4- Unit Group Wave Driven Pumps

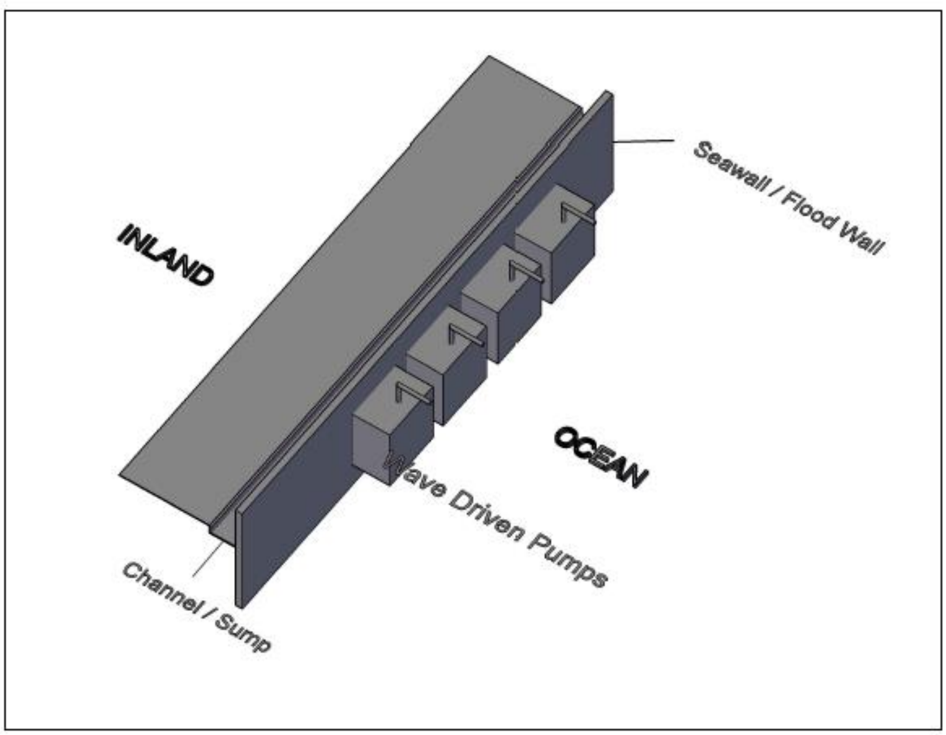


Fig. 5.2.3 Ocean Side View of 4- Unit Group Wave Driven Pump

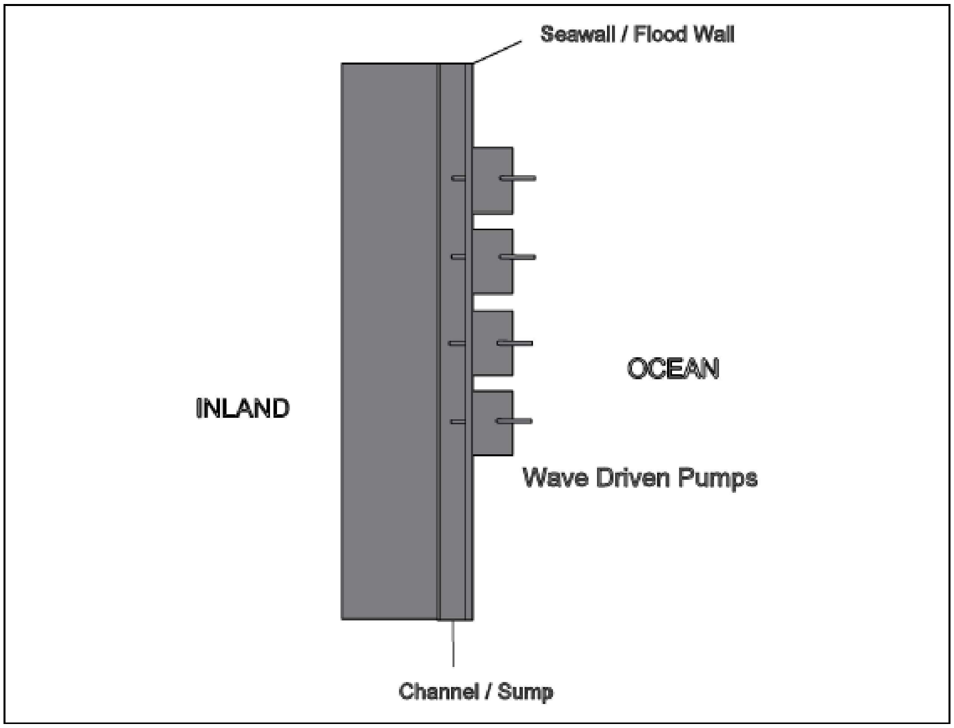


Fig. 5.2.4 Top View of 4- Unit Group Wave Driven Pumps

5.3 Wind Driven Pump

The conceptual sketch for wind driven pump (Fig. 5.3.1) consists of a wind turbine with four or more expanded inlets at the top and a pump at the bottom, both connected by a common shaft. Wind is guided into the turbine through the turbine inlets to operate the pump, and flows out through the turbine outlet to the air; while the flood water is pumped into the receiving water through the pump outlet.

This technology pumps the inland flood water where water levels of flooded areas are lower than the levels of the receiving waters (Fig. 5.3.2), such as lagoons, bays, oceans, or other waterways. For sites with a rich source of wind energy, this alternative works well, and should be used for flood defense. To fully utilize the wind energy, groups of pumps should be installed (Fig.5.3.3).

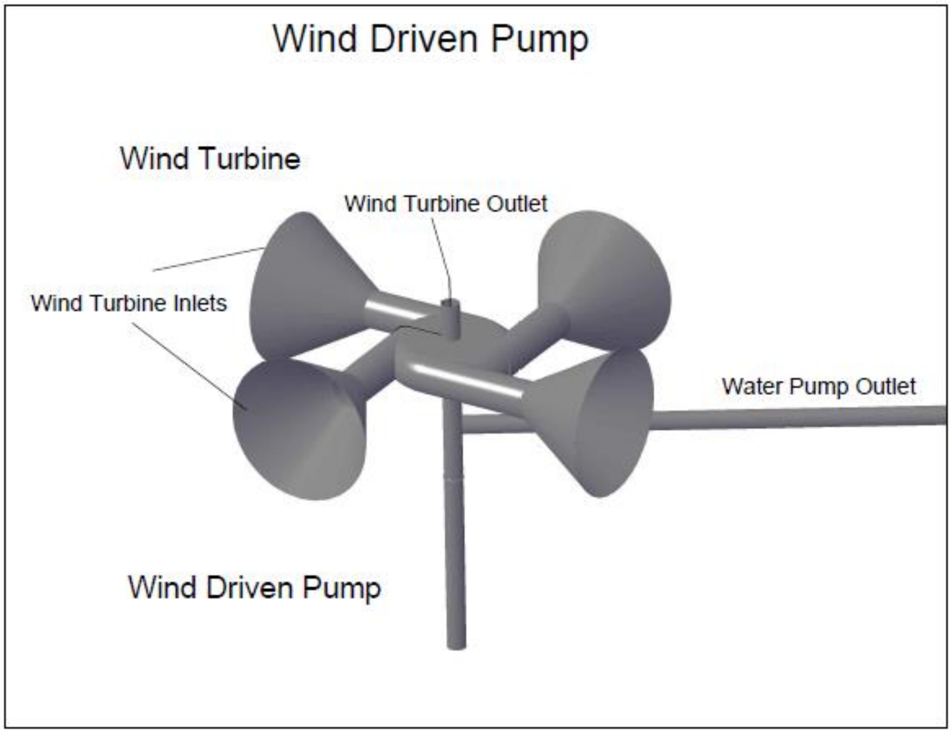


Fig. 5.3.1 Conceptual Sketch of Wind Driven Pump

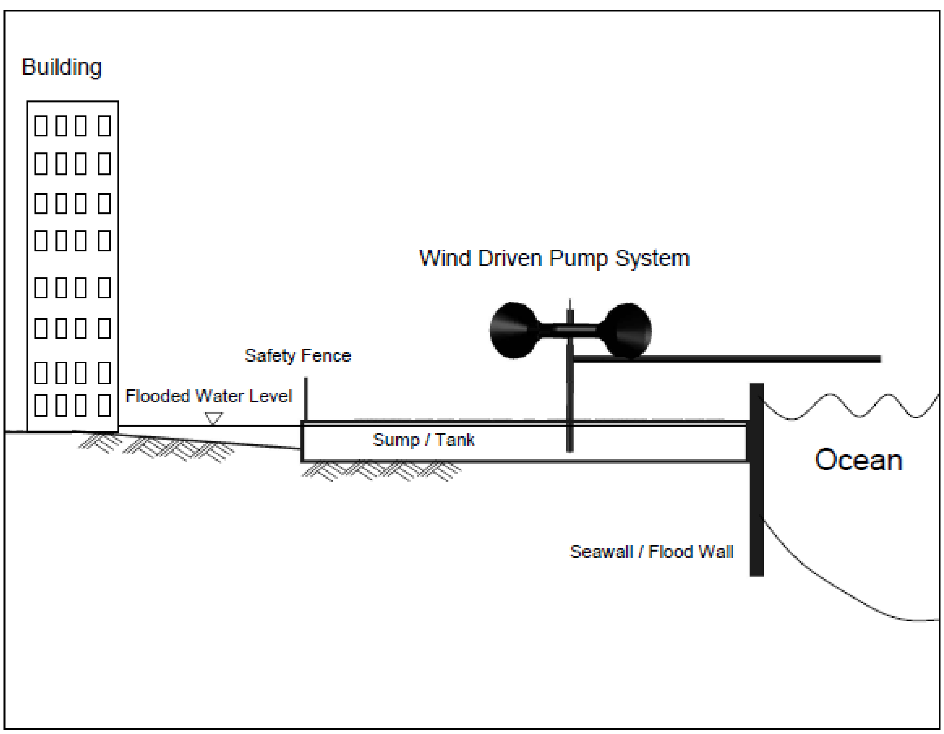


Fig. 5.3.2 System Illustration of Wind Driven Pump Application

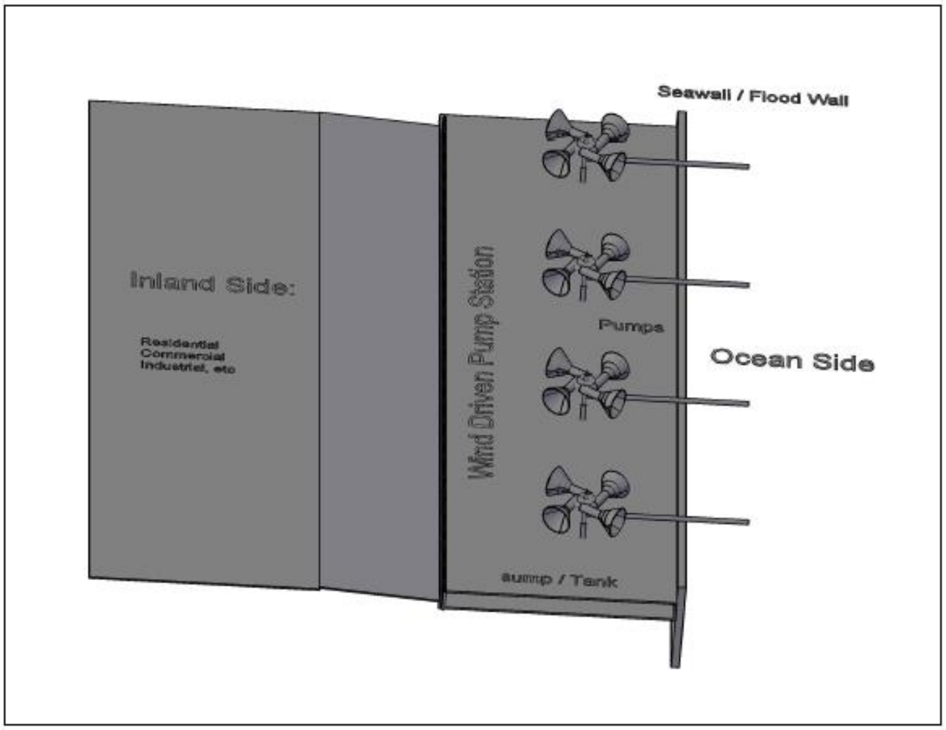


Fig. 5.3.3 Placement of 4- Unit Group Wind Driven Pumps

5.4 Rainwater Flow Driven Venturi Pump

The conceptual sketch for the rainwater flow driven Venturi pump consists of a rainwater flow pipe with a sequence of varied diameters and a pump inlet pipe connected to the throat of the rainwater flow pipe (Fig. 5.4.1). When water passes through the greatly reduced throat, the flow velocity will increase greatly and the pressure will drop dramatically to form a vacuum/negative pressure at the throat. Under this condition, the water can be pulled through the pump inlet and discharged through the outlet.

For field conditions with great changes in elevations (i.e., with a high net water pressure head across the pump system), this technology works well, and it can be used for inland flood defense. The driven rainwater can be collected from roofs and ground surfaces, and stored in the upland containers. Similarly, in additional to saving energy, this method also reduces the flood water accumulation in the developed areas by directly draining the flood water from the upland into the receiving water.

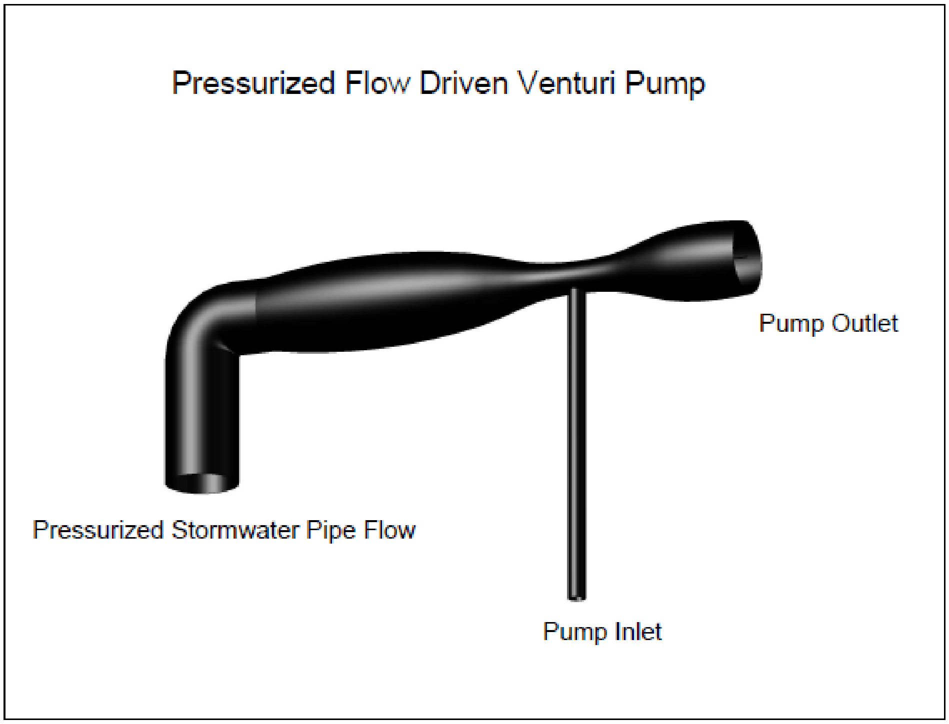


Fig. 5.4.1 Conceptual Sketch of Rainwater Flow Driven Venturi Pump

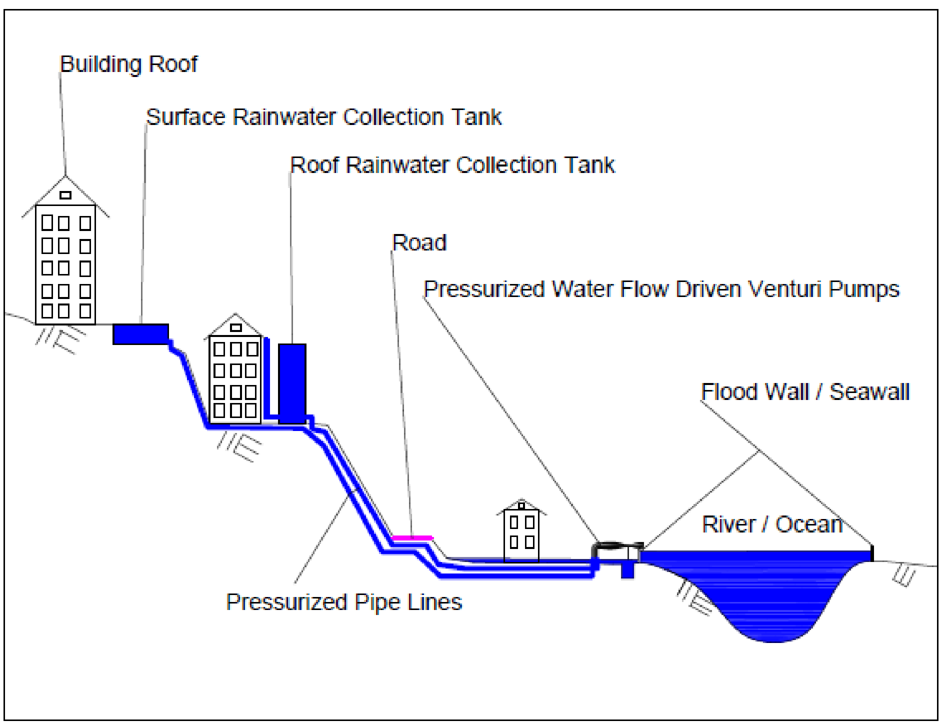


Fig. 5.4.2 System Illustration of Rainwater Flow Driven Venturi Pump Application

5.5 River Flow Driven Venturi Pump

The conceptual sketch for the River flow driven Venturi pump consists of a river flow pipe with varied section diameters and a pump inlet pipe connected to the throat of the river flow pipe (Fig. 5.5.1). Its working principle is same as the rainfall-driven type. This technology can be used for flood defense for residences or areas located along rivers (Fig. 5.5.2).

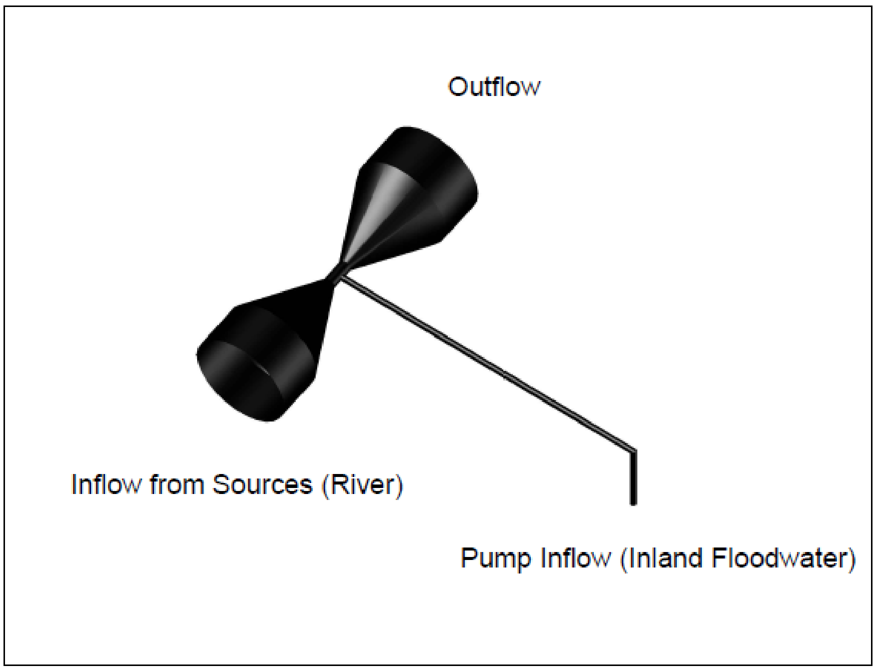


Fig. 5.5.1 Conceptual Sketch of River Flow Driven Venturi Pump

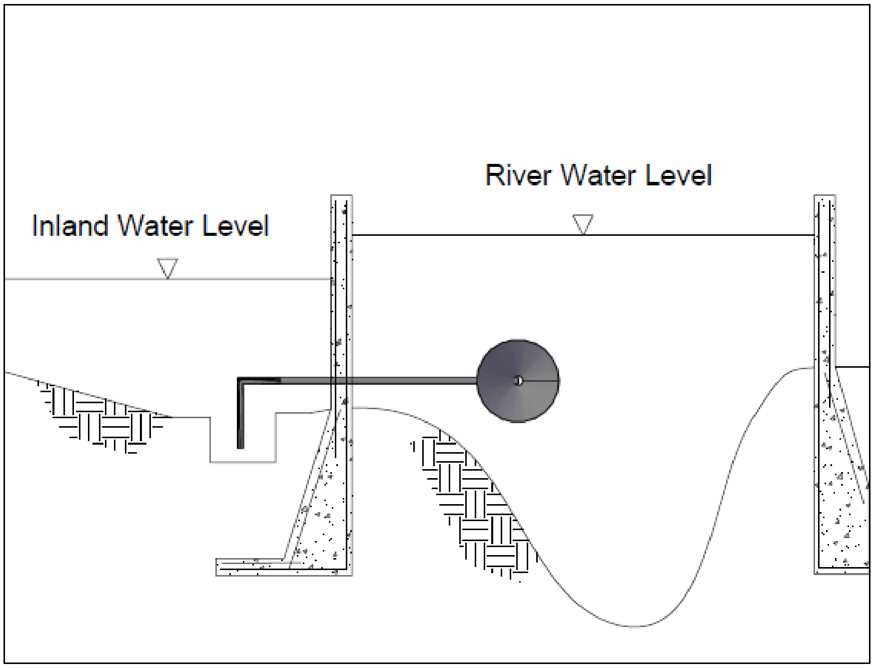


Fig. 5.5.2 System Illustration of River Flow Driven Venturi Pump Application

5.6 Wind Driven Venturi Pump

The conceptual sketch for the wind driven Venturi pump (Fig. 5.6.1) is the same as the water driven Venturi pump. The system design and component placement (Figs. 5.6.2 and 5.6.3) should be at the water's edge. For effectively using the wind energy and improving the system efficiency, a group of eight or more units, (Fig. 5.6.4) should be employed so that wind energy can be collected for any wind direction.

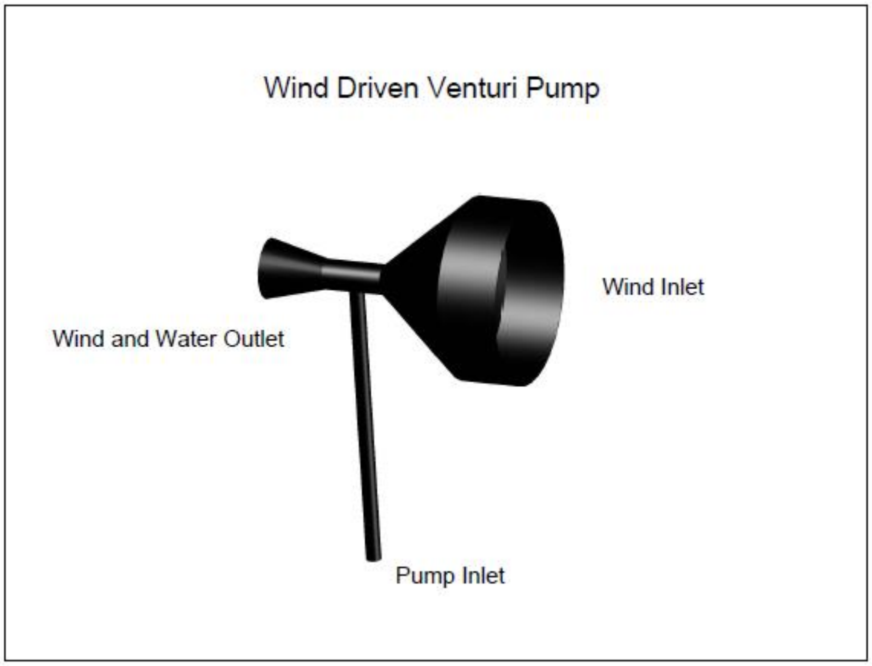


Fig. 5.6.1 Conceptual Sketch of Wind Driven Venturi Pump

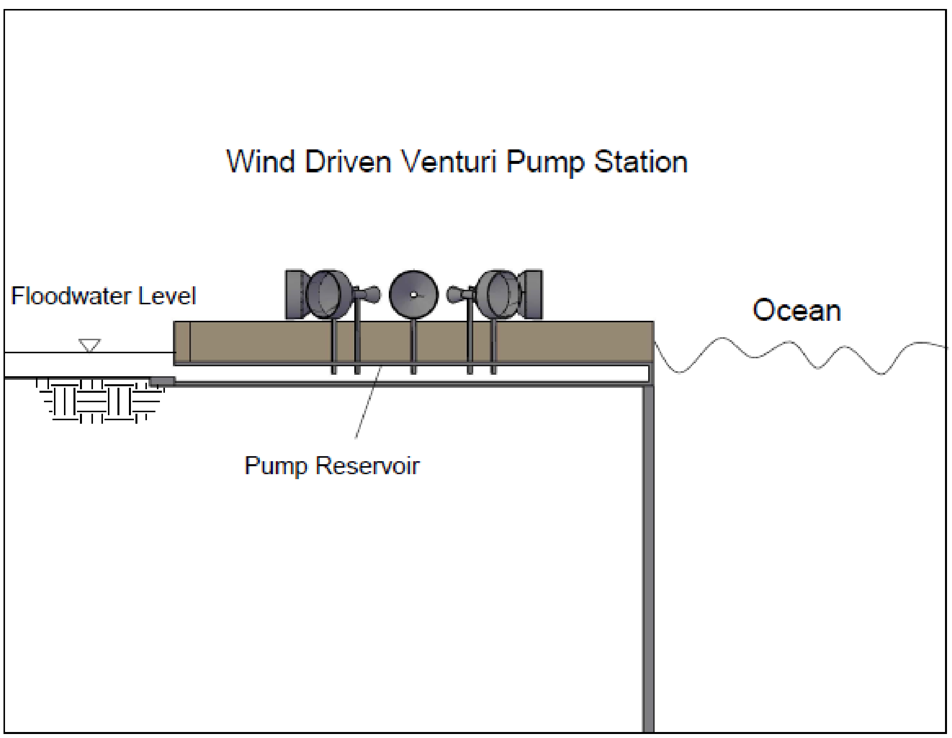


Fig. 5.6.2 System Illustration of Wind Driven Venturi Pump Application

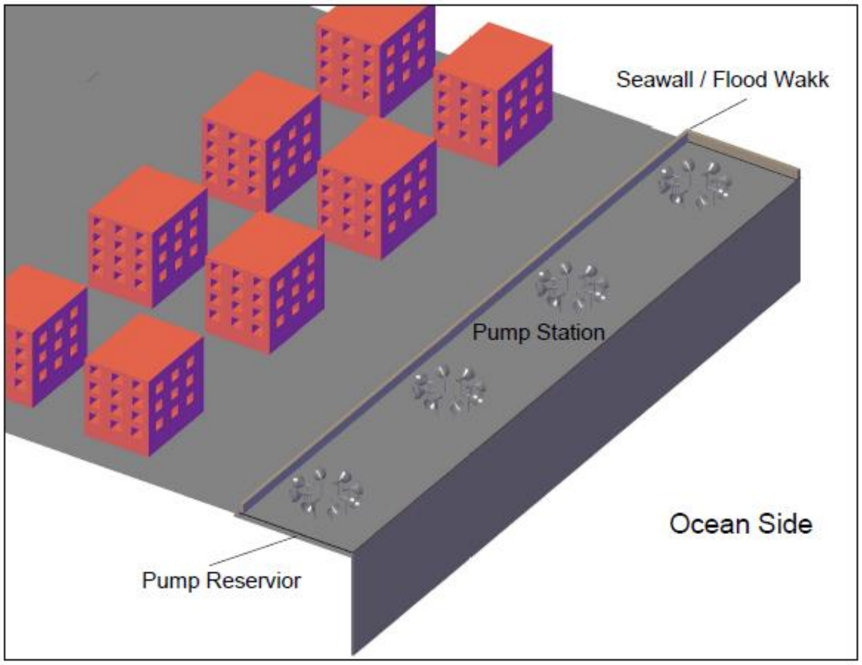


Fig. 5.6.3 A placement of Four Pump Groups

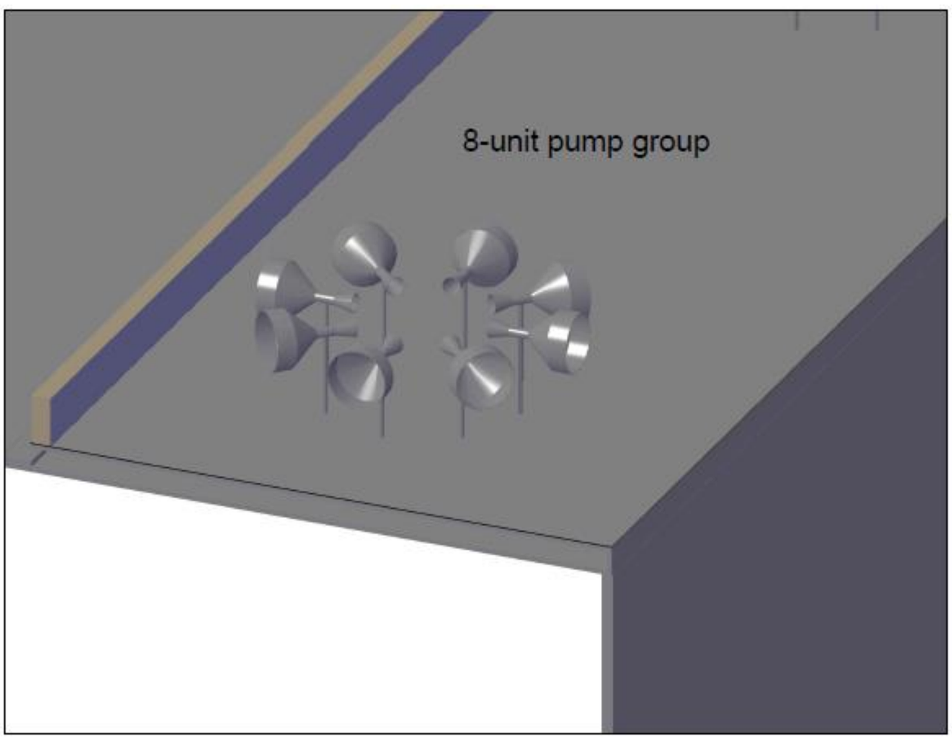


Fig. 5.6.4 An Enlargeed View of a 8-Unit Pump Group

Based on the effective verification by lab and pilot tests, the above technologies, in concert with various flood defense measures such as flood walls/seawalls, can be employed for flood defense among inland and coastal areas. The selection and application of these technologies should be adapted to the specific field conditions. For the given field conditions, one or more of the above technologies can be installed simultaneously along a river or coast line.

An attribute of this technological approach is that, with appropriate structural and visual design for these structures, its application will not only protect lives and properties, it will also benefit the environment, and thus increase the value of adjacent properties. Therefore, these kinds of technological approaches may be more easily accepted by the public.

VI PLACEMENT OF FLOOD DEFENSE MEASURES

Based on a topographical analysis incorporating an Arc GIS tool with field investigations, the selection and placement of flood defense measures for Toms River Township, Seaside Heights Borough, and Lavallette Borough to respond to coastal floods of 10-year, 50-year, and 100-year recurrence intervals as well as rainfall events are described below. The measures for other townships and boroughs are provided in Appendix D and Appendix E.

6.1 Placement of Flood Defense Barriers Responding to a 10-Year Recurrence Interval Coastal Flood Depths

The placement of flood defense measures for Toms River Township, Lavallette Borough, and Seaside Heights Borough is based on the depths of 10-year recurrence interval coastal flood as shown in the following figures. Fig. 6.1.1 presents an overall view of placement of flood defense measures based on the 10-year coastal flood depths. The red lines represent the segments and locations of the proposed bulkheads, concrete floodwalls, levees. The yellow dots represent the locations of the proposed sluice gates or in-water barriers, flood gates, culverts/flap gates.

The flood defense measures are distinguished with identification numbers (Figs. 6.1.2 and 6.1.3) that are associated with Tables 6.1.1, 6.1.2, 6.1.3, and 6.3.4 that provide additional details regarding their specific alternatives.

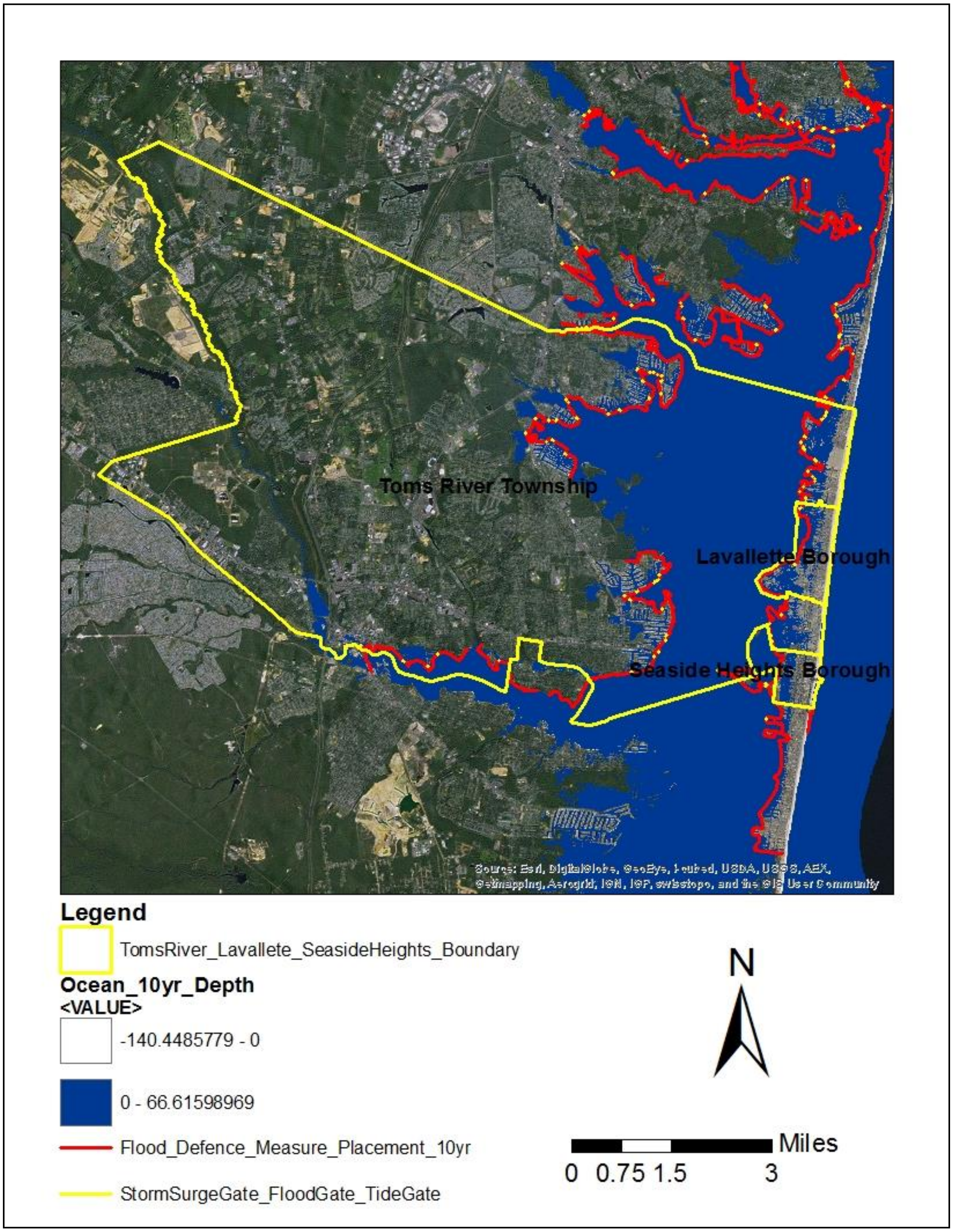


Fig. 6.1.1 An Overall View of Placement of Flood Defense Measures Based on a 10-Year Coastal Flood Depths.

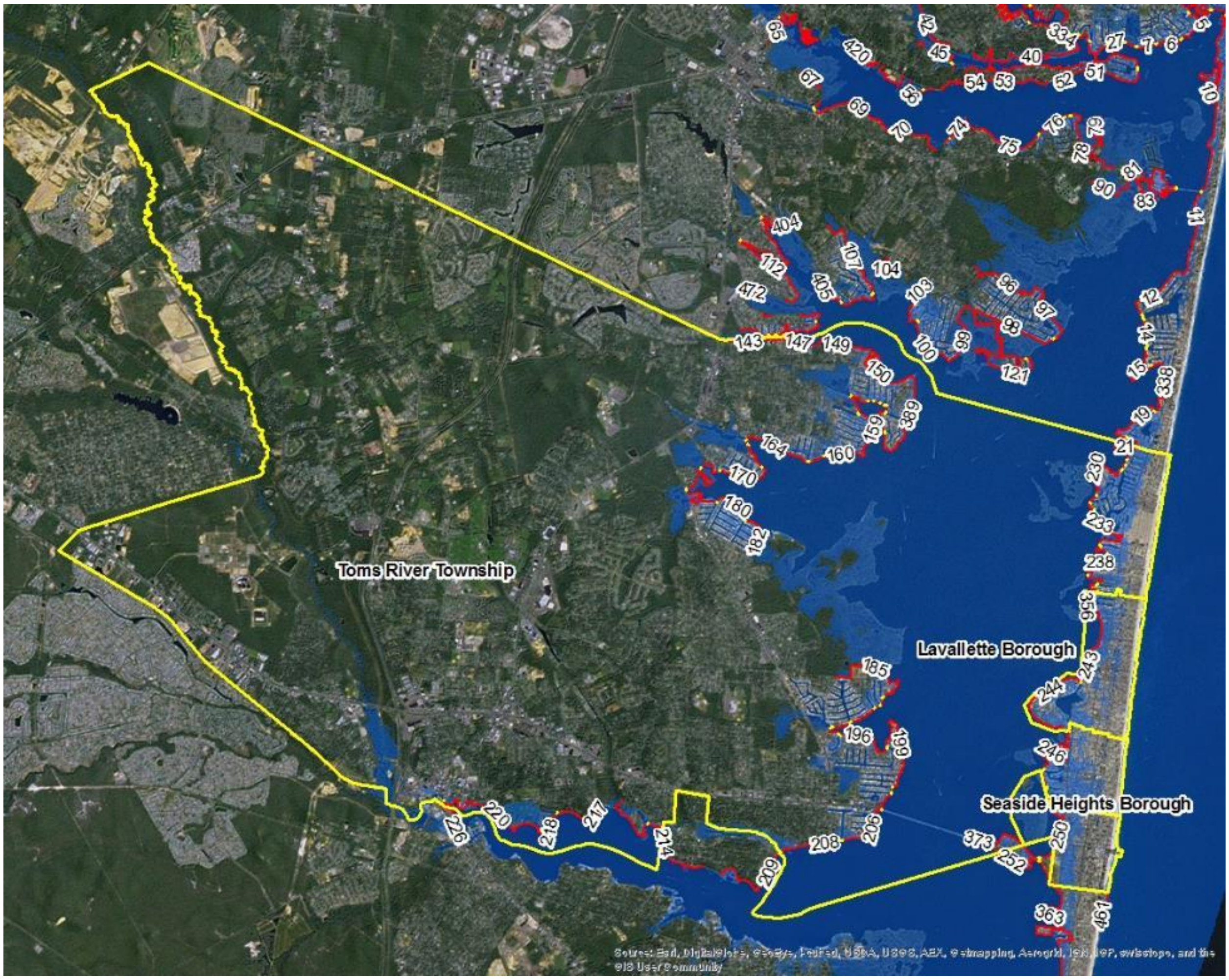


Fig. 6.1.2 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc., for a 10-Year Coastal Flood Depth.

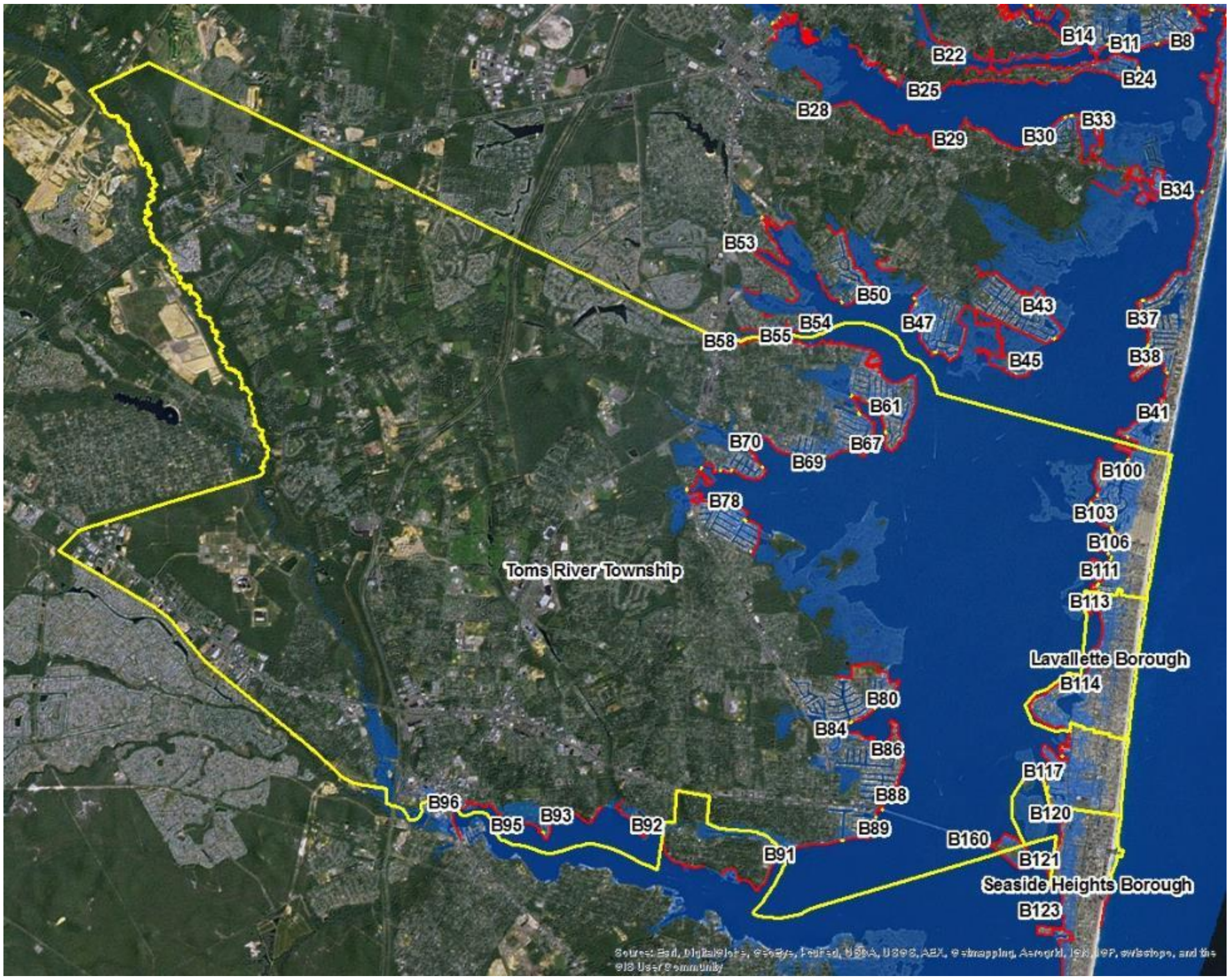


Fig. 6.1.3 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for a 10-Year Coastal Flood Depth.

Table 6.1.1 Existing Field Conditions and Proposed Alternatives for Toms River TWP Based on a 10-Year Coastal Flood Depths

OBJECT ID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
21	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2418.3	0.67
345	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	253.8	2.25
346	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	136.8	2.41
143	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2215.5	1.58
144	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	140.3	2.87
145	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	463.9	3.32
146	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	232.5	2.27
147	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2551.7	0.72
148	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	349.5	2.71
149	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2487.7	1.31
150	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4981.4	1.28
151	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1372.5	0.93
152	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	383.1	0.63
153	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	241.3	0.75
154	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	319.0	1.15
155	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	228.5	0.62
156	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1271.6	0.96
157	Toms River TWP	Salt marsh	Constructing new levee / dike	768.0	2.79
158	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	353.1	1.96
159	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1363.2	1.11
160	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3743.5	0.56

161	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	968.7	0.68
162	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1269.4	1.00
163	Toms River TWP	Sand /earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	263.0	2.04
164	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2657.8	1.19
165	Toms River TWP	Sand /earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	196.4	1.82
166	Toms River TWP	Salt marsh	Constructing new levee / dike	213.3	2.68
167	Toms River TWP	Salt marsh	Constructing new levee / dike	570.4	2.81
168	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	273.2	2.23
169	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	864.2	0.83
170	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2554.1	0.60
171	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	701.4	0.64
172	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	821.1	0.72
173	Toms River TWP	Wooded wetland	Constructing new levee / dike	817.7	1.24
174	Toms River TWP	Wooded wetland	Constructing new levee / dike	252.0	2.94
175	Toms River TWP	Wooded wetland	Constructing new levee / dike	3342.8	1.58
176	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2696.0	2.48
177	Toms River TWP	wooded wetland	Constructing new levee / dike	222.0	2.06
178	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	779.9	1.30
179	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	593.2	1.14
180	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1787.8	1.04
181	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1131.2	1.16
182	Toms River TWP	wooded wetland	Constructing new levee / dike	1466.3	1.34
185	Toms River TWP	wooded wetland	Constructing levee / dike	4153.9	0.00
186	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1768.9	1.62
187	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	301.8	1.99
188	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	86.5	1.49

189	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	563.2	1.84
190	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	307.9	0.71
191	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	825.5	1.25
192	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	549.5	0.54
193	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	432.5	1.11
194	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	91.4	1.64
195	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	718.3	1.35
196	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3029.8	1.25
197	Toms River TWP	Sand/earth bank	Constructing new concrete flood wall with or without removable panel Constructing new concrete flood wall with or without movable panel	643.7	1.55
198	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	235.3	1.81
199	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4409.5	1.45
200	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	559.5	2.02
201	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1235.3	1.12
202	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	278.1	0.54
203	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	672.2	1.60
204	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	123.9	0.98
205	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	663.8	1.46
206	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2394.4	1.15
207	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	406.5	1.34
208	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1892.8	1.06
215	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2000.3	0.97
216	Toms River TWP	Wooded wetland	Constructing new levee / dike	622.6	0.94
217	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3128.1	0.74
218	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1341.6	1.20
219	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1370.5	2.05

220	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2228.2	1.06
221	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1210.6	0.91
222	Toms River TWP	Dock / shipyard	Constructing movable or removal flood panel	841.7	1.26
223	Toms River TWP	E Water St edge	Constructing new concrete flood wall with or without removable panel	117.0	1.35
224	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	943.8	1.91
225	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	174.7	1.60
227	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without removable panel	236.9	2.68
228	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	304.9	1.43
229	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1083.3	2.10
230	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2280.1	1.06
231	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	491.8	1.96
232	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	614.7	1.39
233	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1836.5	1.09
234	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2893.2	1.77
235	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1178.1	1.67
236	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	227.8	1.57
237	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	127.9	2.20
238	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1877.7	1.09
239	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	378.3	1.97
240	Toms River TWP	Salt marsh	Constructing new concrete flood wall with or without removable panel Constructing new metal sheet bulkhead with or without movable panel	584.6	1.28
241	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	363.2	1.54
245	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1486.6	0.71
246	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3918.5	0.85
247	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	950.0	1.09
248	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	378.4	1.80
249	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	611.4	1.55
251	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1001.1	1.58
313	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel	889.1	1.41

			Constructing new metal sheet bulkhead with or without movable panel		
315	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	322.2	0.67
347	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	867.2	1.75
348	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	240.7	2.29
349	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	200.3	1.78
350	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	90.7	1.66
351	Toms River TWP	Bulkhead	Constructing new metal sheet bulkhead with or without movable panel	412.3	1.13
352	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel	232.6	1.73
353	Toms River TWP	Earth bank	Constructing new concrete flood wall with or without removable panel Constructing new metal sheet bulkhead with or without movable panel	221.5	1.86
354	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	272.2	1.52
355	Toms River TWP	Sand / earth bank	Constructing new concrete flood wall with or without removable panel Constructing new metal sheet bulkhead with or without movable panel	268.1	2.17
359	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	422.7	1.66
360	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	676.9	0.82
370	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	876.4	2.29
371	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	503.8	1.54
372	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	1384.5	0.00
373	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	1201.1	0.00
374	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	1719.9	1.99
376	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel	1276.6	1.93

			Constructing new metal sheet bulkhead with or without movable panel		
377	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	201.1	0.66
378	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	485.3	1.18
379	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	460.1	1.12
380	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	858.4	0.25
381	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	488.7	0.87
382	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	344.8	1.01
383	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	269.9	1.75
384	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	149.7	1.26
385	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	173.0	1.60
386	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	539.5	1.64
387	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	378.2	2.43
388	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	652.0	2.45
389	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5738.2	0.55
390	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	222.6	1.58
391	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	802.8	1.72
392	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	568.4	2.00
393	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1349.0	1.26

Table 6.1.2 Existing Field Conditions and Proposed Alternatives for Lavallette Borough Based on a 10-year Coastal Flood Depths

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
242	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	582.7	1.78
243	Lavallette Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3828.6	1.42
244	Lavallette Boro	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6026.3	0.61
356	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1285.8	1.47
357	Lavallette Boro.	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	617.1	1.59
358	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	227.3	1.55

Table 6.1.3 Existing Field Conditions and Proposed Alternatives for Seaside Heights Borough Based on a 10-Year Coastal Flood Depths

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
250	Seaside Heights Boro.	sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2749.1	0.41
361	Seaside Heights Boro.	sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1258.1	1.74

6.2 Placement of Flood Defense Barriers Based on 50-Year Coastal Flood Depths

The placement of flood defense measures for Toms River Township, Lavallette Borough, and Seaside Heights Borough is based on the 50-year recurrence interval coastal flood depths (Fig. 6.2.1). The red lines represent the segments and locations of the proposed bulkheads, concrete floodwalls, levees, and other vertical structures. The yellow lines represent the locations of the proposed sluice gates or in-water barriers, flood gates, culverts/ flap gates, and other means to move water across or through the barriers.

The locations of the flood defense measures are distinguished with identification numbers (Fig. 6.2.2) that are also accompanied with details of the specific alternatives at the sites (Tables 6.2.1, 6.2.2, and 6.2.3).

There are also locations and identification numbers for the proposed flood defense measures such as sluice gates or in-water barriers, flood gates, culverts, and flap gates (Fig. 6.2.3), with accompanying construction details (Table 6.3.4).

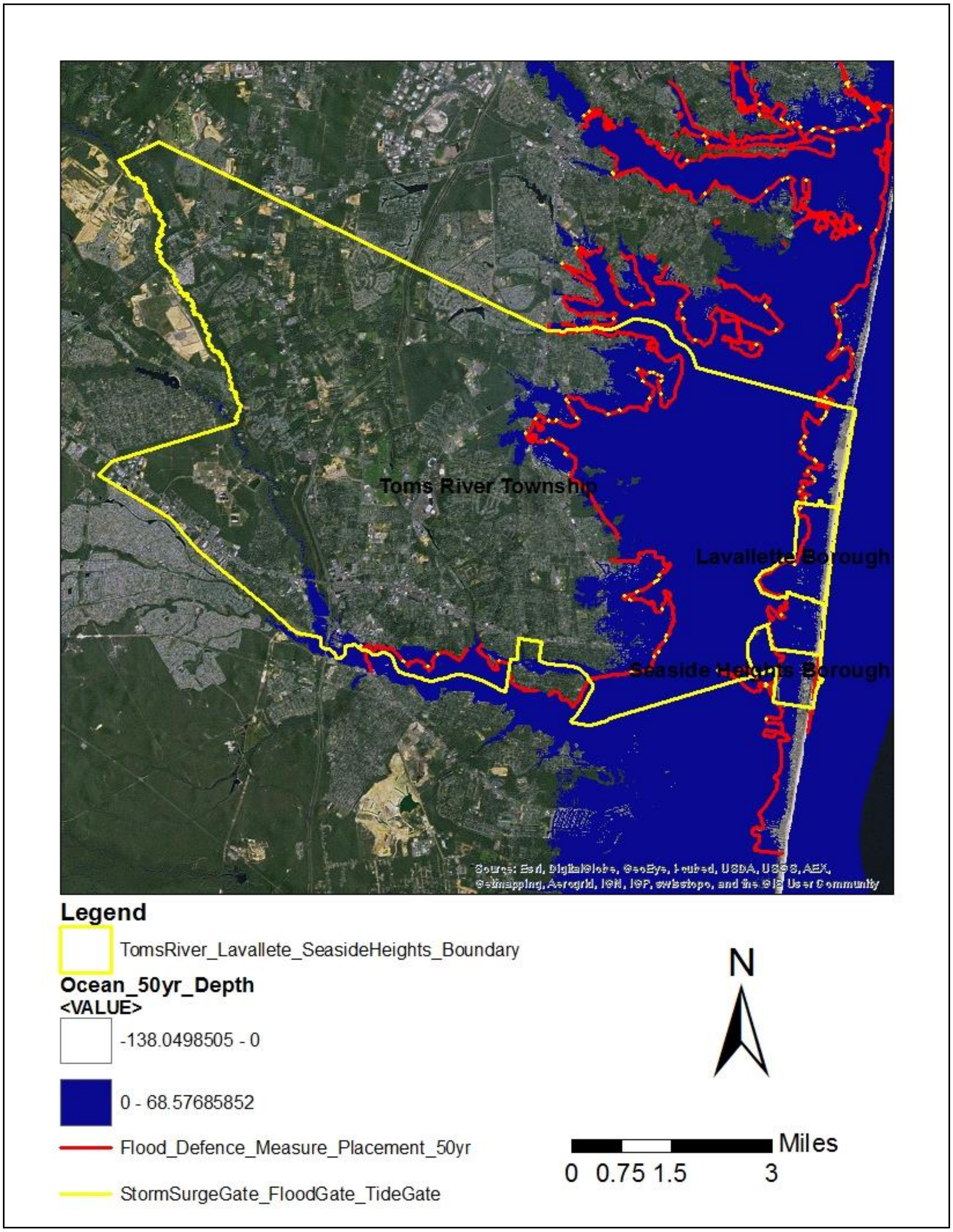


Fig. 6.2.1 An Overall View of Placement of Flood Defense Measures Based on a 50-Year Coastal Flood Depths.

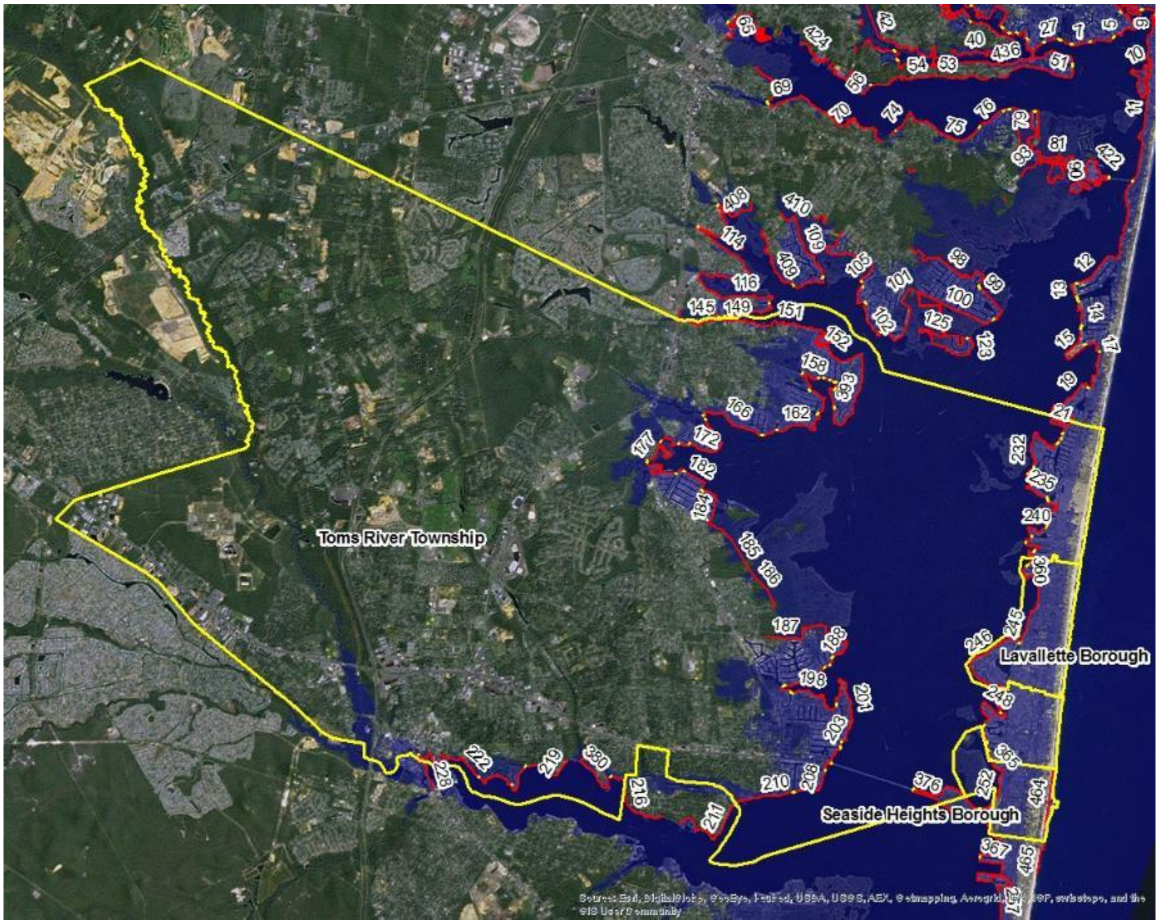


Fig. 6.2.2 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for Coastal Flood Defense Relative to the 50-Year Recurrence Interval Storm Water Depths.

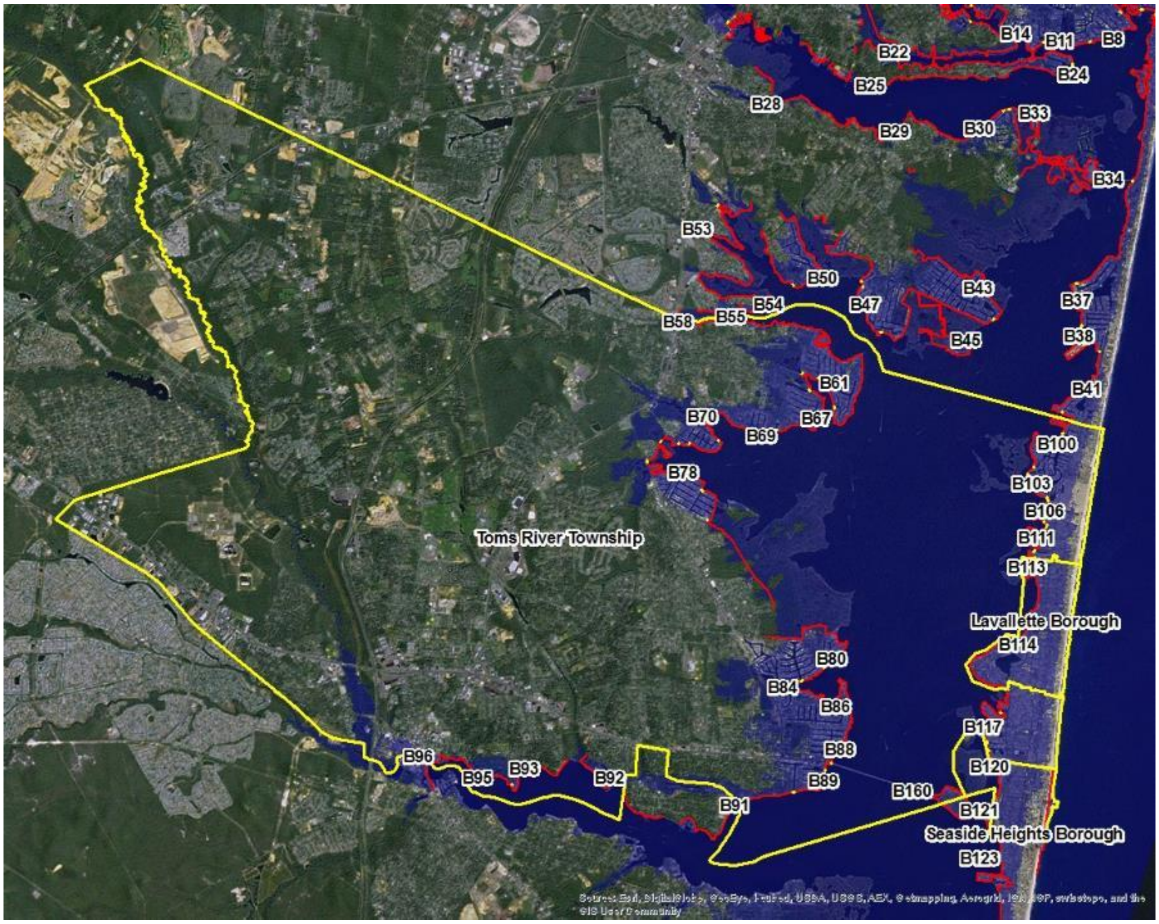


Fig. 6.2.3 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc., for a 50-Year Coastal Flood Defense.

Table 6.2.1 Existing Field Conditions and Proposed Alternatives for Toms River TWP Based on a 50-Year Coastal Flood Depths

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
21	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2418.3	2.42
349	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	253.8	4.53
350	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	136.8	4.41
122	Toms River TWP	Roadway edge	Constructing new concrete flood wall with or without movable panel	174.5	0.00
145	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2215.5	4.17
146	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	140.3	4.90
147	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	463.9	3.86
148	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	232.5	4.06
149	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2551.7	2.80
150	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	349.5	4.91
151	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2487.7	3.56
152	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4981.4	2.97
153	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1372.5	3.06
154	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	383.1	2.69
155	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	241.3	3.00
156	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	319.0	3.15
157	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	228.5	2.96
158	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1271.6	3.11
159	Toms River TWP	Salt marsh bank	Constructing new levee / dike	768.0	5.62
160	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	353.1	3.51
161	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1363.2	2.81

162	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3743.5	2.27
163	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	968.7	2.30
164	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1269.4	3.02
165	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	263.0	4.25
166	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2657.8	3.02
167	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	196.4	4.14
168	Toms River TWP	Salt Marsh	Constructing new levee / dike	213.3	5.38
169	Toms River TWP	Salt Marsh	Constructing new levee / dike	570.4	4.81
170	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	273.2	4.95
171	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	864.2	2.77
172	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2554.1	3.60
173	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	701.4	2.52
174	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	821.1	2.89
175	Toms River TWP	Wooded wetland	Constructing new levee / dike	817.7	3.19
176	Toms River TWP	Wooded wetland	Constructing new levee / dike	252.0	3.43
177	Toms River TWP	Wooded wetland	Constructing new levee / dike	3342.8	3.93
178	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2696.0	4.12
179	Toms River TWP	Wooded wetland	Constructing new levee / dike	222.0	5.28
180	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	779.9	2.88
181	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	593.2	2.82
182	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1787.8	3.20
183	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1131.2	3.53
184	Toms River TWP	Wooded wetland	Constructing new vegetated levee / dike	1466.3	3.30
185	Toms River TWP	Wooded wetland	Constructing new vegetated levee / dike	3448.6	2.59
186	Toms River TWP	Wooded wetland	Constructing new vegetated levee / dike	2848.5	1.63
187	Toms River TWP	Wooded wetland	Constructing new vegetated levee / dike	5323.6	2.34
188	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1768.9	3.09

189	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	301.8	4.51
190	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	86.5	2.65
191	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	563.2	2.87
192	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	307.9	2.92
193	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	825.5	2.75
194	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	549.5	2.63
195	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	432.5	2.71
196	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	91.4	4.47
197	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	718.3	4.38
198	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3029.8	3.40
199	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	643.7	3.81
200	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	235.3	3.76
201	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4409.5	1.44
202	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	559.5	2.15
203	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1235.3	2.41
204	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	278.1	2.73
205	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	672.2	3.14
206	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	123.9	3.02
207	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	663.8	2.99
208	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2394.4	2.76
209	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	406.5	3.60
210	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1892.8	2.46
217	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2000.3	1.94
218	Toms River TWP	Wooded wetland	Constructing new levee / dike	622.6	2.33
219	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3128.1	1.92

220	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1341.6	2.49
221	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1370.5	4.10
222	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2228.2	2.69
223	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1210.6	2.11
224	Toms River TWP	Dock / shipyard	Constructing concrete flood wall with or without removal panel Constructing movable or removable flood panel	841.7	3.04
225	Toms River TWP	E Water St edge	Constructing new concrete flood wall with or without removable panel	117.0	1.87
226	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	943.8	2.94
227	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	174.7	3.77
229	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	236.9	4.70
230	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	304.9	3.32
231	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1083.3	2.22
232	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2280.1	2.31
233	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	491.8	2.43
234	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	614.7	3.64
235	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1836.5	2.91
236	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2893.2	2.17
237	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1178.1	3.75
238	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	227.8	3.87
239	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	127.9	4.93
240	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1877.7	2.74
241	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	378.3	4.29
242	Toms River TWP	Sand / earth bank	Constructing new concrete flood wall with or without removable panel Constructing new metal sheet bulkhead with or without movable panel	584.6	3.92
243	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	363.2	2.16
247	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1486.6	1.91
248	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3918.5	3.06
249	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	950.0	3.38

250	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	378.4	3.57
251	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	611.4	3.57
253	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1001.1	3.28
317	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	889.1	3.47
319	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	322.2	2.62
351	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	867.2	3.55
352	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	240.7	5.18
353	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	200.3	2.84
354	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	90.7	4.09
355	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	412.3	3.12
356	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	232.6	3.68
357	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	221.5	2.97
358	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	272.2	3.24
359	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	268.1	4.55
363	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	422.7	2.45
364	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	676.9	2.69
374	Toms River TWP	Sand / earth bank	Constructing new bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	876.4	3.06
375	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	503.8	1.79
376	Toms River TWP	Route 37 edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1384.5	1.16

377	Toms River TWP	Route 37 edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1201.1	0.83
378	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1719.9	2.76
380	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1276.6	3.23
381	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	201.1	2.33
382	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	485.3	3.09
383	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	460.1	2.63
384	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	858.4	3.17
385	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	488.7	3.08
386	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	344.8	4.08
387	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	269.9	3.92
388	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	149.7	3.53
389	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	173.0	3.24
390	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	539.5	3.94
391	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	378.2	4.79
392	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	652.0	3.45
393	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5738.2	2.58
394	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	222.6	4.36
395	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	802.8	3.89

396	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	568.4	4.38
397	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1349.0	3.19

Table 6.2.2 Existing Field Conditions and Proposed Alternatives for Lavallette Borough Based on 50-Year Coastal Flood Depths

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
244	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	582.7	3.73
245	Lavallette Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3828.6	3.04
246	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6026.3	1.98
360	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1285.8	3.5
361	Lavallette Boro.	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	617.1	3.99
362	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	227.3	3.75

Table 6.2.3 Existing Field Conditions and Proposed Alternatives for Seaside Heights Borough Based on a 50-Year Coastal Flood Depths

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
252	Seaside Heights Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2749.1	1.47
365	Seaside Heights Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1258.1	3.91
464	Seaside Heights Boro.	Sand dune (Ocean side)	Constructing new concrete flood wall (seawall) with or without movable panel Constructing new dune with or without rubble or tube core New dune with layer cemented by spraying sand color cement liquid below top sand layer	4182.9	6.09

6.3 Placement of Flood Defense Barriers Based on 100-Year Coastal Flood Depths

The placement of flood defense measures for Toms River Township, Lavallette Borough, and Seaside Heights Borough based on the 100-year recurrence interval coastal flood depths is shown in Fig. 6.3.1. The red lines represent the segments and locations of the proposed bulkheads, concrete floodwalls, levees, and other vertical structures. The yellow lines represent the locations of the proposed sluice gates or in-water barriers, flood gates, culverts/flap gates, and other means to move water across or through the barriers.

The locations of the flood defense measures are distinguished with identification numbers (Fig. 6.3.2) that are also accompanied with details of the specific alternatives at the sites (Tables 6.3.1, 6.3.2, and 6.3.3).

There are also locations and identification numbers for the proposed flood defense measures such as sluice gates or in-water barriers, flood gates, culverts, and flap gates (Fig. 6.3.3), with accompanying measure details (Table 6.3.4).

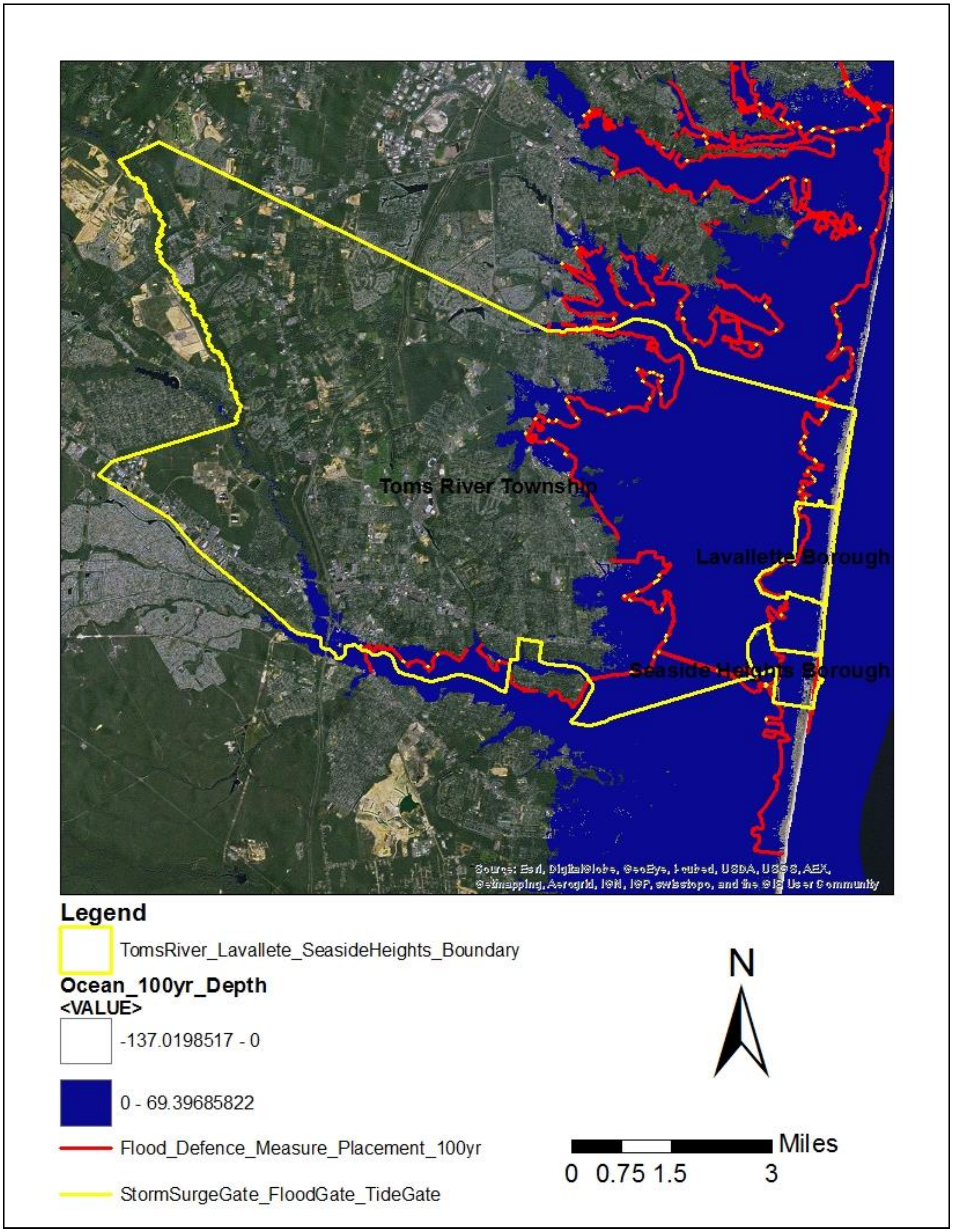


Fig. 6.3.1 Placement of Flood Defense Measures Based on 100-Year Coastal Flood Depths.

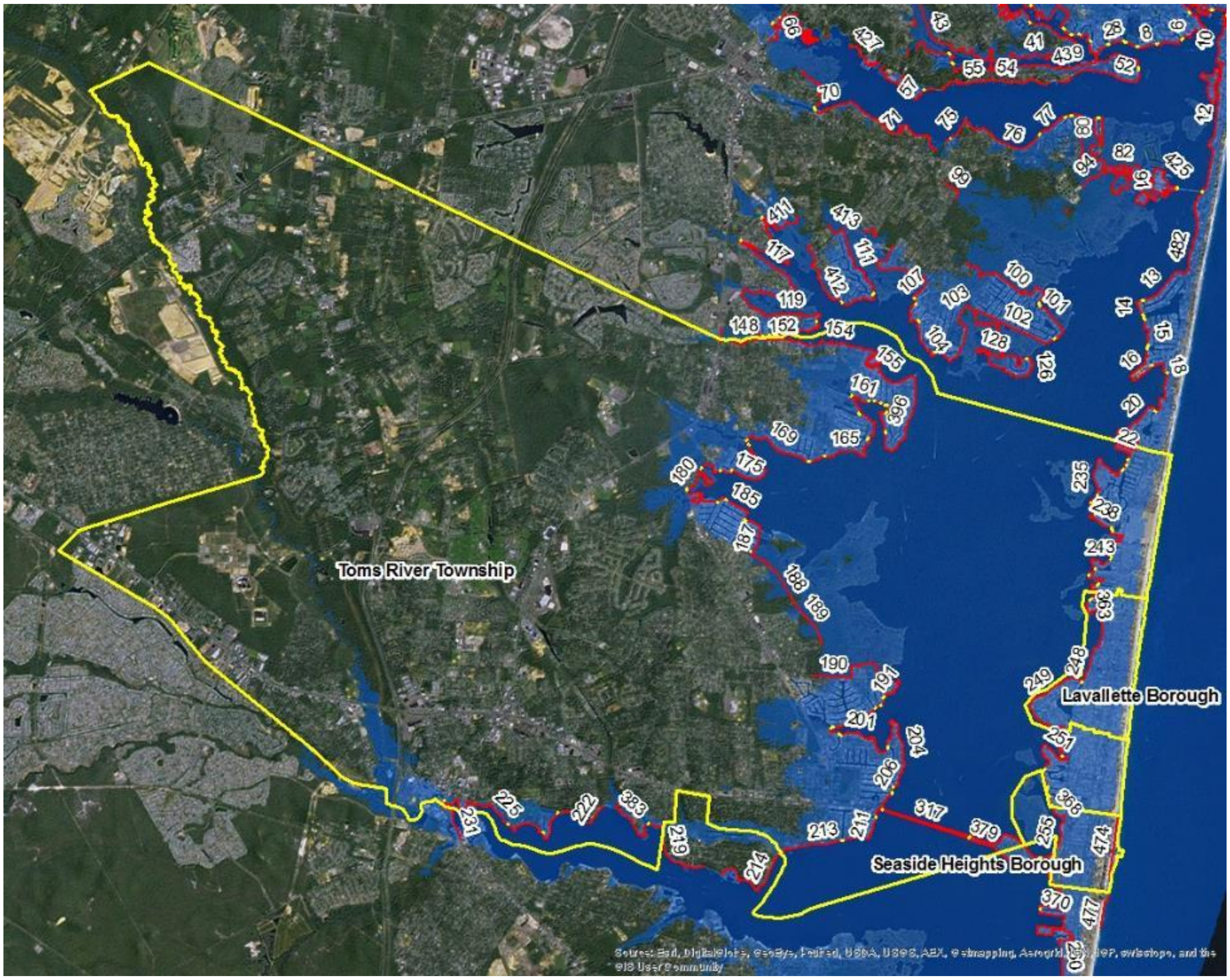


Fig. 6.3.2 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee for Coastal Flood Defense Appropriate to the 100-Year Recurrence Interval Storm Water Depths.

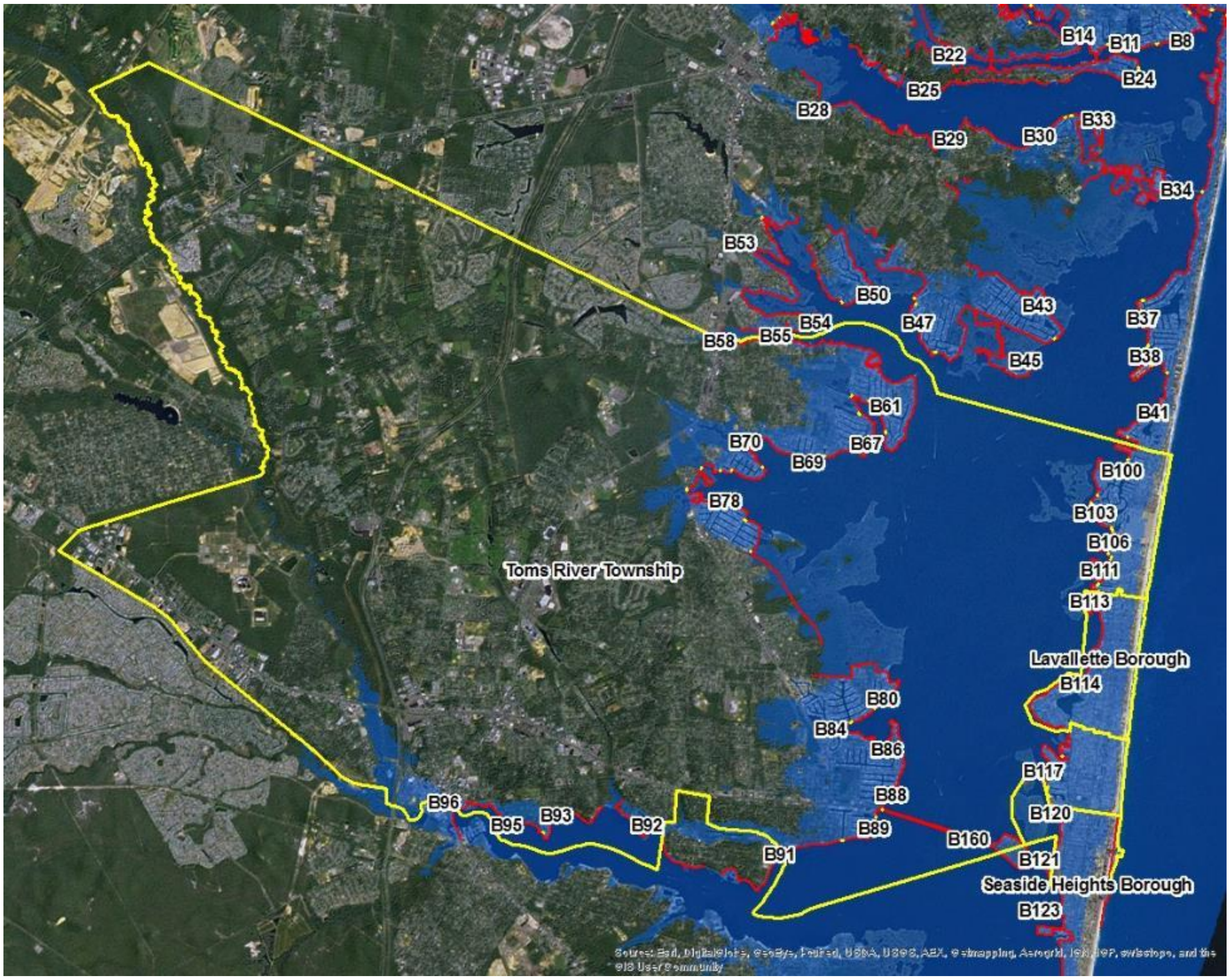


Fig. 6.3.3 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate for a 100-Year Coastal Flood Defense Appropriate to the 100-Year Recurrence Interval Storm Water Depths.

Table 6.3.1 Existing Field Conditions and Proposed Alternatives for Toms River TWP Based on a 100-year Coastal Flood Depths

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
22	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2418.3	3.42
352	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	253.8	5.28
353	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	136.8	5.35
125	Toms River TWP	Roadway edge	Constructing concrete flood wall with or without removable panel	174.5	1.62
148	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2215.5	4.33
149	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel Adding concrete flood wall with or without movable panel	140.3	5.21
150	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	463.9	4.79
151	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel Adding concrete flood wall with or without movable panel	232.5	4.77
152	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2551.7	4.17
153	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	349.5	5.89
154	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2487.7	4.41
155	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4981.4	3.61
156	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1372.5	4.18
157	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	383.1	3.65
158	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	241.3	3.99
159	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	319.0	4.39
160	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	228.5	4.14
161	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1271.6	4.11
162	Toms River TWP	Salt marsh bank	Constructing new levee / dike	768.0	6.76

163	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	353.1	4.05
164	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1363.2	3.54
165	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3743.5	3.10
166	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	968.7	3.37
167	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1269.4	3.99
168	Toms River TWP	Sand / vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	263.0	4.94
169	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2657.8	4.21
170	Toms River TWP	Sand / vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	196.4	5.47
171	Toms River TWP	Salt marsh	Constructing new levee / dike	213.3	6.38
172	Toms River TWP	Salt marsh	Constructing new levee / dike	570.4	5.83
173	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	273.2	5.56
174	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	864.2	3.98
175	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2554.1	3.63
176	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	701.4	3.62
177	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	821.1	3.91
178	Toms River TWP	Wooded wetland	Constructing new levee / dike	817.7	4.15
179	Toms River TWP	Wooded wetland	Constructing new levee / dike	252.0	4.67
180	Toms River TWP	Wooded wetland	Constructing new levee / dike	3342.8	5.18
181	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2696.0	4.40
182	Toms River TWP	Wooded wetland	Constructing new levee / dike	222.0	5.74
183	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	779.9	4.64
184	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	593.2	4.27
185	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1787.8	3.84
186	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1131.2	4.01
187	Toms River TWP	Wooded wetland	Constructing new levee / dike	1466.3	3.67
188	Toms River TWP	Wooded wetland	Constructing new levee / dike	3448.6	3.71
189	Toms River TWP	Wooded wetland	Constructing new levee / dike	2848.5	2.19

190	Toms River TWP	Wooded wetland	Constructing new levee / dike	5323.6	3.04
191	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1768.9	4.21
192	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel	301.8	5.51
			Constructing new concrete flood wall with or without movable panel		
193	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	86.5	4.58
194	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	563.2	3.63
195	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	307.9	3.85
196	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	825.5	3.69
197	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	549.5	3.68
198	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	432.5	3.64
199	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	91.4	5.45
200	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	718.3	5.30
201	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3029.8	4.17
202	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	643.7	4.78
203	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	235.3	6.03
204	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4409.5	2.78
205	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	559.5	4.00
206	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1235.3	3.26
207	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	278.1	3.61
208	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	672.2	3.34
209	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	123.9	4.26
210	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	663.8	4.85
211	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2394.4	4.02
212	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	406.5	4.77
213	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1892.8	3.31
220	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2000.3	2.87

221	Toms River TWP	Wooded wetland	Constructing new levee / dike	622.6	2.69
222	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3128.1	4.36
223	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1341.6	3.16
224	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1370.5	5.27
225	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2228.2	3.96
226	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1210.6	2.90
227	Toms River TWP	Dock / shipyard	Constructing concrete flood wall with or without removal panel Constructing movable or removable flood panel	841.7	3.49
228	Toms River TWP	E Water St edge	Constructing new concrete flood wall with or without removable panel	117.0	2.51
229	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	943.8	4.40
230	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	174.7	5.14
232	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	236.9	5.90
233	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	304.9	4.25
234	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1083.3	4.22
235	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2280.1	3.16
236	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	491.8	4.27
237	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	614.7	4.06
238	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1836.5	4.06
239	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2893.2	3.91
240	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1178.1	4.87
241	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	227.8	5.04
242	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	127.9	5.64
243	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1877.7	3.42
244	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	378.3	5.22
245	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	584.6	4.63
246	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	363.2	3.19
250	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1486.6	3.94

251	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3918.5	3.78
252	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	950.0	4.13
253	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	378.4	4.44
254	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	611.4	4.52
256	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1001.1	4.17
317	Toms River TWP	Bridge over water	Constructing movable or removable flood panel	4876.3	1.31
318	Toms River TWP	Bridge over water	Constructing movable or removable flood panel	4878.6	1.66
320	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	889.1	4.55
322	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	322.2	3.30
354	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	867.2	4.01
355	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	240.7	5.15
356	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	200.3	3.09
357	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	90.7	4.36
358	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	412.3	4.29
359	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	232.6	4.68
360	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	221.5	3.23
361	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	272.2	4.32
362	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	268.1	4.74
366	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	422.7	3.49
367	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	676.9	4.04
377	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	876.4	3.83

378	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	503.8	3.64
379	Toms River TWP	Route 37 edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1384.5	1.70
380	Toms River TWP	Route 37 edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1201.1	2.35
381	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1719.9	3.65
383	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1276.6	4.20
384	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	201.1	3.50
385	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	485.3	4.30
386	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	460.1	4.13
387	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	858.4	4.09
388	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	488.7	3.49
389	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	344.8	5.01
390	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	269.9	4.66
391	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	149.7	4.91
392	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	173.0	4.41
393	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	539.5	4.81
394	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	378.2	4.26
395	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	652.0	4.60

396	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5738.2	3.63
397	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	222.6	4.94
398	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	802.8	4.47
399	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	568.4	4.46
400	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1349.0	4.33

Table 6.3.2 Existing Field Conditions and Proposed Alternatives for Lavallette Borough Based on a 100-year Coastal Flood Depths

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
247	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	582.7	5.05
248	Lavallette Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3828.6	3.23
249	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6026.3	3.03
363	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1285.8	4.18
364	Lavallette Boro.	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	617.1	4.63
365	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	227.3	4.74

Table 6.3.3 Existing Field Conditions and Proposed Alternatives for Seaside Heights Borough Based on a 100-year Coastal Flood Depths

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
255	Seaside Heights Boro.	Beach earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2749.1	2.50
368	Seaside Heights Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1258.1	4.77
474	Seaside Heights Boro.	Sand dune (Ocean side)	Constructing new concrete flood wall (Seawall) with or without movable panel Constructing new dune with or without rubble or tube core New dune with layer cemented by spraying sand color cement liquid below top sand layer	4182.9	9.19

Table 6.3.4 Proposed Sluice Gate/In-Water Barrier/Flood Gate/Culvert/Flap Gate

ID No.	Mun. Name	Barrier_Gate_Type	Length
66	Toms River Township	Sluice Gate or In-Water Mobile Barrier	125.2
67	Toms River Township	Sluice Gate or In-Water Mobile Barrier	114.2
68	Toms River Township	Sluice Gate or In-Water Mobile Barrier	149.0
69	Toms River Township	Sluice Gate or In-Water Mobile Barrier	73.9
70	Toms River Township	Sluice Gate or In-Water Mobile Barrier	60.3
71	Toms River Township	Sluice Gate or In-Water Mobile Barrier	101.0
72	Toms River Township	Sluice Gate or In-Water Mobile Barrier	85.7
73	Toms River Township	Sluice Gate or In-Water Mobile Barrier	117.9
74	Toms River Township	Sluice Gate or In-Water Mobile Barrier	135.4
75	Toms River Township	Sluice Gate or In-Water Mobile Brier	77.3
76	Toms River Township	Sluice Gate or In-Water Mobile Barrier	111.4
77	Toms River Township	Sluice Gate or In-Water Mobile Barrier	75.5
78	Toms River Township	Sluice Gate or Culvert with Flap Gate	56.2
79	Toms River Township	Sluice Gate	86.8
80	Toms River Township	Sluice Gate or In-Water Mobile Barrier	93.6
81	Toms River Township	Sluice Gate or In-Water Mobile Barrier	69.6
82	Toms River Township	Sluice Gate or Culvert with Flap Gate	42.4
83	Toms River Township	Flap Gate	81.4
84	Toms River Township	Sluice Gate or In-Water Mobile Barrier	81.1
85	Toms River Township	Sluice Gate or In-Water Mobile Barrier	101.0
86	Toms River Township	Sluice Gate or In-Water Mobile Barrier	92.7
87	Toms River Township	Sluice Gate or In-Water Mobile Barrier	86.4
88	Toms River Township	Sluice Gate or In-Water Mobile Barrier	73.1
89	Toms River Township	Sluice Gate or In-Water Mobile Barrier	87.9
90	Toms River Township	Sluice Gate or In-Water Mobile Barrier	144.1

91	Toms River Township	Sluice Gate or In-Water Mobile Barrier	157.8
92	Toms River Township	Sluice Gate or In-Water Mobile Barrier	138.4
93	Toms River Township	Sluice Gate or In-Water Mobile Barrier	116.8
94	Toms River Township	Sluice Gate or In-Water Mobile Barrier	100.5
95	Toms River Township	Sluice Gate or In-Water Mobile Barrier	108.0
96	Toms River Township	Sluice Gate or In-Water Mobile Barrier	90.4
97	Toms River Township	Sluice Gate or In-Water Mobile Barrier	90.2
98	Boundary of Toms River TWP and Island Height Boro	Sluice Gate or In-Water Mobile Barrier	80.9
99	Toms River Township	Sluice Gate or In-Water Mobile Barrier	48.6
100	Toms River Township	Sluice Gate or In-Water Mobile Barrier	89.3
101	Toms River Township	Sluice Gate or In-Water Mobile Barrier	64.5
102	Toms River Township	Sluice Gate or In-Water Mobile Barrier	48.9
103	Toms River Township	Sluice Gate	80.2
104	Boundary of Toms River TWP and S. Toms River Boro	Sluice Gate	50.0
105	Toms River Township	Sluice Gate or In-Water Mobile Barrier	73.2
107	Toms River Township	Sluice Gate or In-Water Mobile Barrier	65.7
108	Toms River Township	Sluice Gate or In-Water Mobile Barrier	121.7
109	Toms River Township	Sluice Gate or In-Water Mobile Barrier	93.9
110	Toms River Township	Sluice Gate or In-Water Mobile Barrier	89.9
111	Toms River Township	Sluice Gate or In-Water Mobile Barrier	265.9
112	Toms River Township	Sluice Gate or In-Water Mobile Barrier	226.5
113	Toms River Township	Sluice Gate or In-Water Mobile Barrier	93.6
114	Toms River Township	Sluice Gate or In-Water Mobile Barrier	38.5
115	Toms River Township	Sluice Gate or In-Water Mobile Barrier	36.0
116	Toms River Township	Sluice Gate or In-Water Mobile Barrier	38.4
117	Toms River Township	Sluice Gate or In-Water Mobile Barrier	73.2

118	Toms River Township	Sluice Gate or In-Water Mobile Barrier	42.2
119	Toms River Township	Sluice Gate or In-Water Mobile Barrier	98.8
120	Toms River Township	Sluice Gate or In-Water Mobile Barrier	90.0
121	Lavallette Borough	Sluice Gate or In-Water Mobile Barrier	104.6
122	Lavallette Borough	Sluice Gate or In-Water Mobile Barrier	62.5
123	Boundary of Toms River TWP and Lavallette Boro	Sluice Gate or In-Water Mobile Barrier	98.9
124	Toms River Township	Sluice Gate	39.2
125	Toms River Township	Sluice Gate or In-Water Mobile Barrier	144.4
126	Toms River Township	Sluice Gate or In-Water Mobile Barrier	71.6
127	Toms River Township	Sluice Gate or In-Water Mobile Barrier	102.3
128	Toms River Township	Sluice Gate or In-Water Mobile Barrier	92.8
129	Seaside Heights Borough	Sluice Gate	125.1
130	Seaside Heights Borough	Sluice Gate	119.1
131	Seaside Park Borough	Sluice Gate or In-Water Mobile Barrier	87.4
170	Toms River Township	Flood Gate	94.7
173	Toms River Township	Flood Gate	96.9

6.4 Placement of Pump Stations Based on Rainfall Design Frequency

In low-lying areas or areas with placement of flood defense measures such as floodwall or levee along the water bodies, rainfall may create inland flood water levels that are lower than the outside waterways. As a result, the inland flood water cannot be drained by the gravitational method during the flood period. Under these conditions, to solve the inland drainage problem, pumping stations should be used to pump the inland flood waters into adjacent rivers or bays.

In this report, the placement of pump stations is focused on Toms River Township, Seaside Heights Borough, and Lavallette Borough only. For other townships/boroughs, the same methodology can be followed to estimate the required pump capacities and numbers for each station.

6.4.1 Placement of Pump Stations

The location of pump stations is determined with consideration of the topographical characteristics and the placement of flood defense measures. Fifty nine (59) pump stations are proposed for Toms River Township (Fig. 6.4.1). For Seaside Heights Borough and Lavallette Borough, two (2) and five (5) pump stations are proposed, respectively (Fig. 6.4.1).

The required pump capacity and unit numbers are determined for each pump station, keyed to the station identification number (Tables 6.7.1, 6.7.2, and 6.7.3). Each of the station locations is associated with other flood defense measures such as increased bulkhead height with or without movable flood panels over the top of bulkhead, and a sluice gate or in-water barrier (an example of the association is in Fig. 6.4.2).

To determine the required pump capacities and unit numbers, the USGS's regression equations are used to estimate the peak discharges for 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year rainfall events. They are described Section 6.4.2.

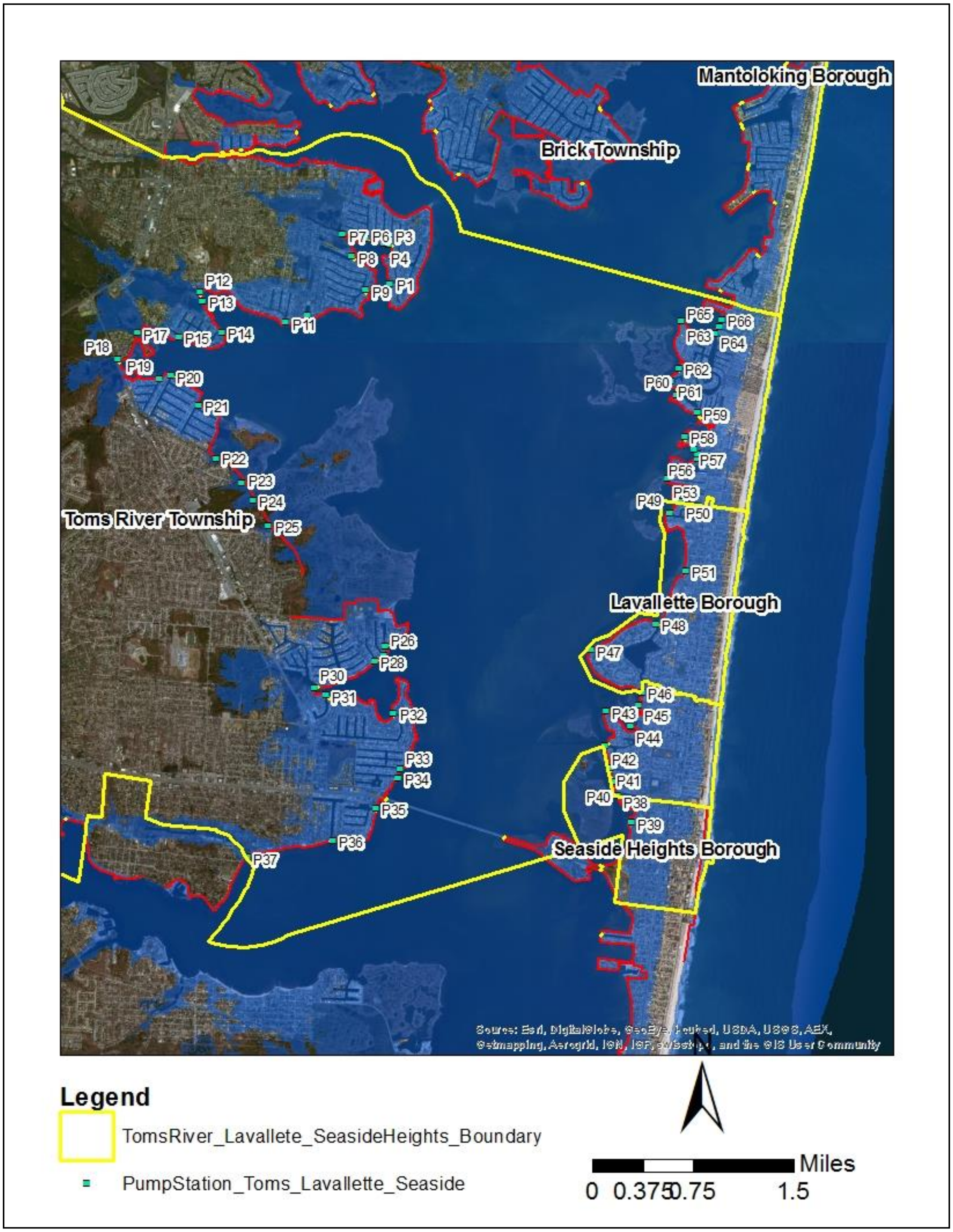


Fig. 6.4.1 Locations and Identification Numbers of Pump Stations

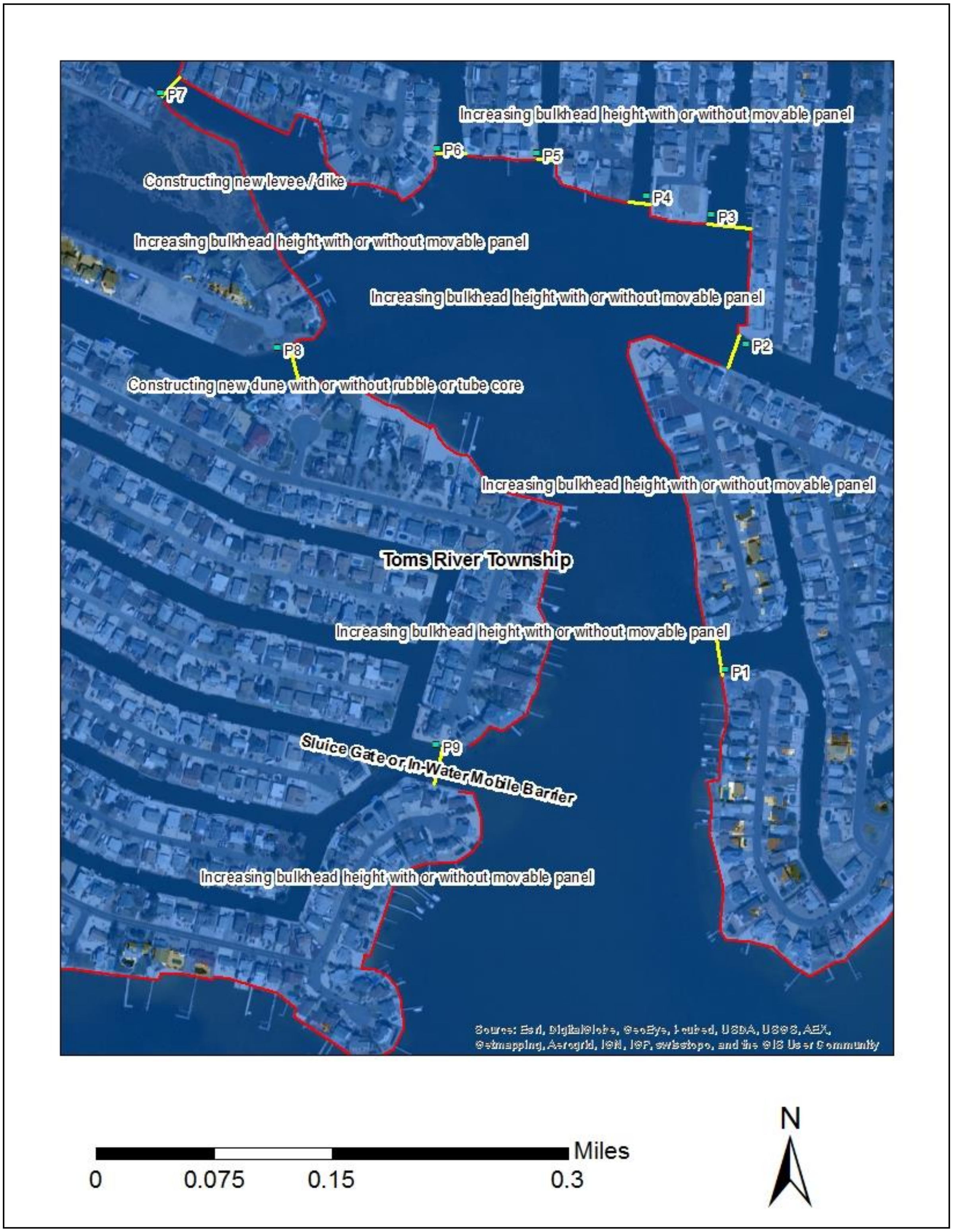


Fig. 6.4.2 An Enlargement of the Placement of Pump stations and Other Flood Defense Measures in a Portion of Toms River

6.4.2 Design Frequency and Pump capacity and Numbers

For a given drainage basin, the peak discharge is a function of the basin's physical properties such as land use/land cover, soil type, shape, slope, size, as well as climate factors such as rainfall intensity and distribution. For Ocean County, the rainfall amounts for 24-hour rainfall periods are as great as 9.2 inches for a 100-year return period (Table 6.5).

Table 6.5 Ocean County 24-Hour Rainfall Frequency and Magnitude, in Inches

County	Maximum Rainfall Event						
	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Ocean	3.0	3.4	4.5	5.4	6.7	7.9	9.2

(Source: NJDOT Roadway Design Manual, 2013b)

For the accurate estimation of peak discharge, the detailed hydrological and hydraulic analyses should be performed. However, to conserve time and effort and focus on the engineering responses to the flood events, at this stage the USGS's regional regression equations are employed for estimating the peak discharge. For New Jersey, the regression equations for 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year rainfall events are as follows (USGS, 1994):

$$Q_2 = 25.6A^{0.89}S^{0.25}ST^{-0.56}I^{0.25} \tag{7.1}$$

$$Q_5 = 39.7A^{0.88}S^{0.26}ST^{-0.54}I^{0.22} \tag{7.2}$$

$$Q_{10} = 54.0A^{0.88}S^{0.27}ST^{-0.53}I^{0.20} \tag{7.3}$$

$$Q_{25} = 78.2A^{0.86}S^{0.27}ST^{-0.52}I^{0.18} \tag{7.4}$$

$$Q_{50} = 104A^{0.85}S^{0.26}ST^{-0.51}I^{0.16} \tag{7.5}$$

$$Q_{100} = 136A^{0.84}S^{0.26}ST^{-0.51}I^{0.14} \tag{7.6}$$

$$I = 0.117D^{0.792-0.039\log D} \tag{7.7}$$

Where Q = peak discharge in cubic feet per second; A = drainage area in square miles; S = channel slope in feet per mile; ST = storage area in basin which is the percentage of the basin occupied by lakes and swamps; I = impervious cover in percent (this is a function of population density); and D = basin population density in persons per square mile. The variables A, S, and ST can be determined from measurements on existing topographic maps; whereas the variable I can be calculated by using census datasets. Calculations of the values of the watershed variables were determined for Toms River Township, Seaside Heights Borough, and Lavallette Borough (Table 6.6.1) and they are applied to the equations to determine the peak discharges (Table 6.6.2).

Table 6.6.1 Calculated Values for A, S, ST, and I

Mun. Name	A (sq. mi)	S (ft/mi)	ST (percentage)	I (percent)
Toms River TWP	12.88	11.9800	1.2160	27.92
Seaside Heights Borough	0.491*	22.6800	1.0000	56.48
Lavallette Borough	1.03	10.3100	1.0000	32.54

* The total area of Seaside Heights Borough is 0.74 sq. mi. The urban area is 0.491 sq. mi

Table 6.6.2 Calculated Peak Discharges

Mun. Name	Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)
Toms River TWP	954.10	1343.24	1755.79	2264.73	2684.67	3201.69
Seaside Heights Borough	81.32	116.10	150.30	203.66	243.91	296.33
Lavallette Borough	112.48	160.79	208.81	281.88	341.49	416.40

Based on the calculated peak discharges, the numbers of pump stations in each sub-watershed (Fig. 6.4.3) as well as the required pump capacities and pump numbers for each station are evenly assigned to the geographical area for each design frequency (Tables 6.7.1, 6.7.2, and 6.7.3).

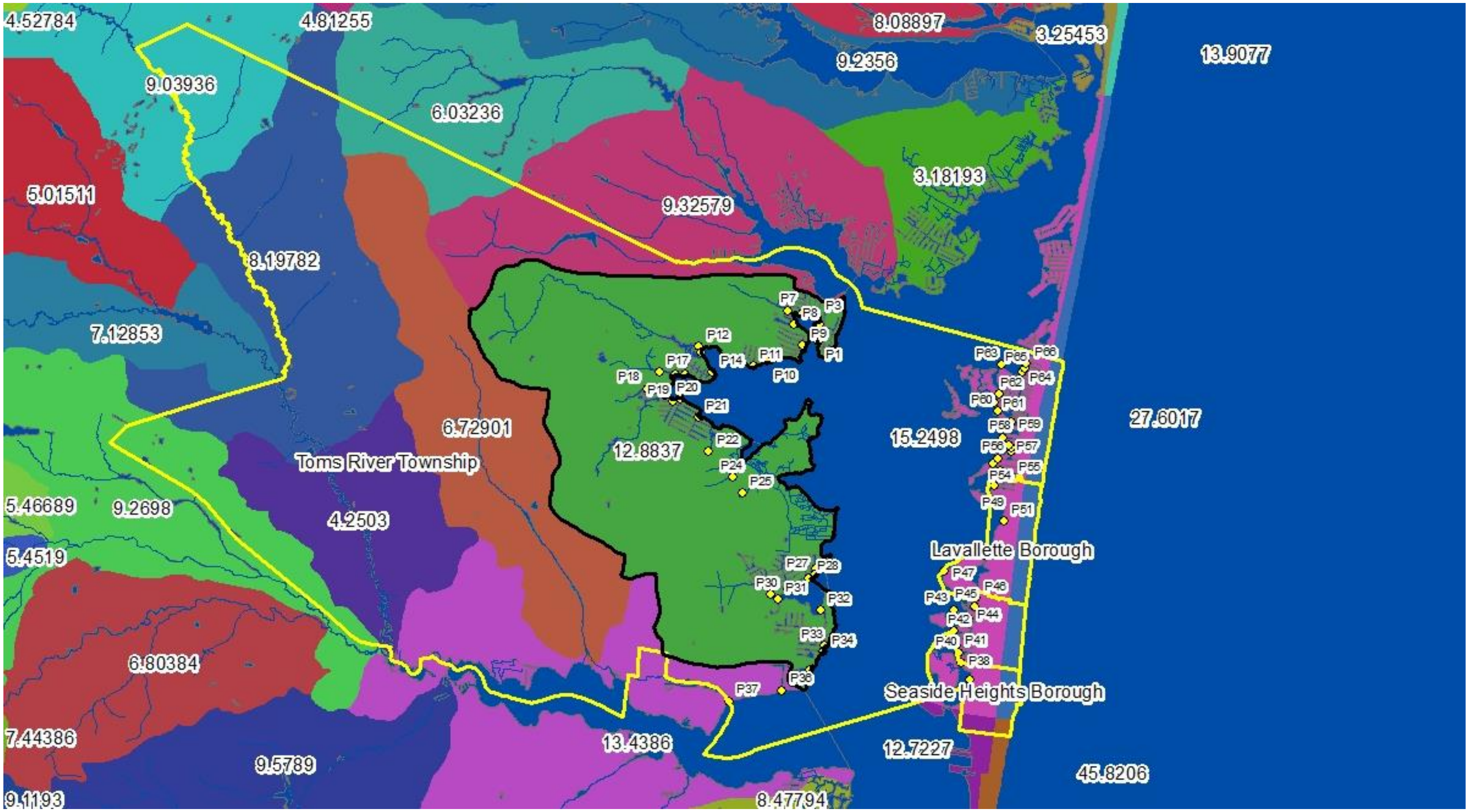


Fig. 6.4.3 Configuration of Sub-watersheds and Pump Stations Distribution

Table 6.7.1 Required Pump Capacities and Numbers for Each Pump Station for Toms River Township

Station ID	Mun__Name	2-year		5-year		10-year		25-year		50-year		100-year	
		$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps
P1	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P2	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P3	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P4	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P5	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P6	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P7	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P8	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P9	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P10	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P11	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P12	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P13	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P14	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P15	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P16	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P17	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P18	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P19	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P20	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P21	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P22	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P23	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P24	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P25	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P26	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*

P27	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P28	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P29	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P30	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P31	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P32	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P33	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P34	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P35	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P36	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P37	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P40	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P41	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P42	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P43	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P44	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P45	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P46	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P52	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P53	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P54	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P55	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P56	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P57	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P58	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P59	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P60	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P61	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P62	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P63	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*

P64	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P65	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
P66	Toms River TWP	16.17	1+1*	22.77	1+1*	29.76	1+1*	38.39	2+1*	45.50	2+1*	54.27	3+1*
Total Pump Numbers		**118**		**118**		**118**		**177**		**177**		**236**	

Note: * Backup pump numbers

Table 6.7.2 Required Pump Capacities and Numbers for Each Pump Station for Seaside Heights Borough

Station ID	Mun__Name	2-year		5-year		10-year		25-year		50-year		100-year	
		$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps
P38	Seaside Heights Boro	40.66	2+1*	58.05	3+1*	75.15	4+1*	101.83	5+1*	121.955	6+1*	148.165	7+1*
P39	Seaside Heights Boro	40.66	2+1*	58.05	3+1*	75.15	4+1*	101.83	5+1*	121.955	6+1*	148.165	7+1*
Total Pump Numbers		**6**		**8**		**10**		**12**		**14**		**16**	

Note: * Backup pump numbers

Table 6.7.3 Required Pump Capacities and Numbers for Each Pump Station for Lavallette Borough

Station ID	Mun__Name	2-year		5-year		10-year		25-year		50-year		100-year	
		$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps	$Q_{p(req)}$ (cfs)	No. of Pumps
P47	Lavallette Boro	22.50	1+1*	32.16	2+1*	41.76	2+1*	56.38	3+1*	68.30	3+1*	83.28	4+1*
P48	Lavallette Boro	22.50	1+1*	32.16	2+1*	41.76	2+1*	56.38	3+1*	68.30	3+1*	83.28	4+1*
P49	Lavallette Boro	22.50	1+1*	32.16	2+1*	41.76	2+1*	56.38	3+1*	68.30	3+1*	83.28	4+1*
P50	Lavallette Boro	22.50	1+1*	32.16	2+1*	41.76	2+1*	56.38	3+1*	68.30	3+1*	83.28	4+1*
P51	Lavallette Boro	22.50	1+1*	32.16	2+1*	41.76	2+1*	56.38	3+1*	68.30	3+1*	83.28	4+1*
Total Pump Numbers		**10**		**15**		**15**		**20**		**20**		**25**	

Note: * Backup pump numbers

VII COST ESTIMATE

Due to the limited time and the shortage of information on many of the critical factors such as damage amount of dollars for each flood frequency, a detailed benefit-cost analysis is not possible at this time. However, at this time, a general cost estimate may be considered.

Based on the 10-year, 50-year, and 100-year recurrence interval coastal flood events, coupled with the various flood defense measures, the estimated costs may be approached. The unit prices of flood defense products used for cost estimation are obtained from website searches and personal contacts with the relevant manufacturers. There is not sufficient detailed information to determine an accurate unit cost because the conditions are site-specific, and the search indicates a wide range of responses.

The cost estimates are focused on Toms River TWP, Lavallette Borough, and Seaside Heights Borough. However, the detailed quantities for each selected flood defense measures for the whole study area, except for the pump station selection and placement, are provided in the appendices of this report.

7.1 Cost Estimate Based on 10-Year Recurrence Interval Coastal Flood Depths

For each protecting location, there are one to three alternatives recommended (Tables 6.1.1 to 6.3.4.) Due to the shortage of the detailed information about unit prices for the selected measures, as well as to reduce the scale of the calculation, only one alternative is used for the cost estimate. The cost comparisons among alternatives for selecting the best alternative are not performed at this stage.

If the unit prices for exact measures are not available, the costs are estimated with unit prices from the similar flood defense measures. Moreover, to include the wave impact, a free board of 1.5 ft is employed to approximate the wave height. Based on 10-year coastal flood depths, coupled with the current sea level, as well as the projected 2050 and 2100 sea level rises (1.5 ft and 3.5 ft, respectively), the estimated costs for Toms River TWP, Lavallette Borough, and Seaside Heights Borough are calculated (Tables 7.1.1, 7.1.2, and 7.1.3).

There are six outfalls in Seaside Heights Borough. For Toms River Township and Lavallette Borough, they are unknown. The estimated total costs for outfall flap gates/check valves are projected from that of Seaside Heights Borough.

Table 7.1.1 Selected Flood defense Measures and Associated Costs Based on a 10-Year Flood Depths for Toms River Township

Selected Flood Defense Measures	Measure Length (mile)	Based on Current Sea Level (1)		Projected 2050 Sea Level (2)		Projected 2100 Sea Level (3)	
		Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)
Constructing new metal sheet bulkhead with or without movable panel	4.90	3.16	18.08	4.66	19.05	6.66	20.34
Constructing new concrete flood wall with or without movable panel	0.35	3.14	0.28	4.64	0.42	6.64	0.60
Increasing bulkhead height with or without movable panel	18.69	2.79	26.16	4.29	40.96	6.29	60.70
Constructing new levee / dike	2.35	3.34	49.72	4.84	74.57	6.84	99.43
Constructing movable or removal flood panel	0.16	2.76	0.23	4.26	0.36	6.26	0.53
Sluice Gate or In-Water Mobile Barrier	1.09	N/A	204.80	N/A	234.40	N/A	273.90
Flood Gate	0.02	N/A	0.75	N/A	0.75	N/A	0.75
Flap Gate/Check Valves	N/A	N/A	0.53	N/A	23.46	N/A	23.46
Pump Stations	N/A	N/A	41.90[4]	N/A	41.90[4]	N/A	41.90[4]
New Sewer lines along flood barriers inside	25.91	N/A	41.05	N/A	41.05	N/A	41.05
		Round Total =	**385**	**Round Total =**	**477**	**Round Total =**	**564**

(1) Costs estimated based on current sea level
(2) Costs estimated based on sea level rise of 2050
(3) Costs estimated based on sea level rise of 2100
(4) Pump stations costs estimated with regression equation from USACE (2011)

Table 7.1.2 Selected Flood defense Measures and Associated Costs Based on a 10-Year Flood Depths for Lavallette Borough

Selected Flood Defense Measures	Measure Length (mile)	Based on Current Sea Level (1)		Projected 2050 Sea Level (2)		Projected 2100 Sea Level (3)	
		Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)
Constructing new metal sheet bulkhead with or without movable panel	0.84	3.01	3.11	4.51	3.27	6.51	3.49
Increasing bulkhead height with or without movable panel	1.54	2.85	1.91	4.35	3.13	6.35	4.76
Sluice Gate or In-Water Mobile Barrier	0.05	N/A	7.77	N/A	8.92	N/A	10.44
Flap Gate/Check Valves	N/A	N/A	0.06	N/A	0.06	N/A	0.06
Pump Stations	N/A	N/A	7.89	N/A	7.89	N/A	7.89
New Sewer lines along flood barriers inside	2.38	N/A	3.77	N/A	3.77	N/A	3.77
		Round Total =	**26**	**Round Total =**	**28**	**Round Total =**	**31**

Table 7.1.3 Selected Flood defense Measures and Associated Costs Based on a 10-Year Flood Depths for Seaside Heights Borough

Selected Flood Defense Measures	Measure Length (mile)	Based on Current Sea Level (1)		Projected 2050 Sea Level (2)		Projected 2100 Sea Level (3)	
		Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)
Constructing new metal sheet bulkhead with or without movable panel	0.76	2.58	2.74	4.1	2.89	6.1	3.09
Sluice Gate or In-Water Mobile Barrier	0.02	N/A	13.10	N/A	14.94	N/A	17.38
Flap Gate/Check Valves	N/A	N/A	0.02	N/A	0.02	N/A	0.02
Pump Stations	N/A	N/A	**5.55**	N/A	**5.55**	N/A	**5.55**
New Sewer lines along flood barriers inside	0.76	N/A	1.20	N/A	1.20	N/A	1.20
		Round Total =	**23**	**Round Total =**	**25**	**Round Total =**	**28**

7.2 Cost Estimate Based on 50-Year Recurrence Interval Coastal Flood Depths

Similarly, based on 50-year coastal flood, coupled with the current sea level, as well as 2050 and 2100 sea level rises, the estimated costs for Toms River Township, Lavallette Borough, and Seaside Heights Borough are calculated (Tables 7.2.1, 7.1.2, and 7.2.3).

Table 7.2.1 Selected Flood Defense Measures and Associated Costs Based on 50-Year Recurrence Interval Flood Depths for Toms River Township

Selected Flood Defense Measures	Measure Length (mile)	Based on Current Sea Level (1)		Projected 2050 Sea Level (2)		Projected 2100 Sea Level (3)	
		Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)
Constructing new metal sheet bulkhead with or without movable panel	5.03	5.11	19.78	6.61	20.78	8.61	22.11
Constructing new concrete flood wall with or without movable panel	0.29	4.44	0.37	5.94	0.48	7.94	0.64
Increasing bulkhead height with or without movable panel	18.77	4.53	42.63	6.03	57.49	8.03	77.31
Constructing new levee / dike	3.77	5.15	79.58	6.65	119.38	8.65	159.17
Sluice Gate or In-Water Mobile Barrier	1.09	N/A	360.33	N/A	402.98	N/A	459.85
Flood Gate	0.02	N/A	0.75	N/A	0.75	N/A	0.75
Flap Gate/Check Valves	N/A	N/A	0.53	N/A	23.46	N/A	23.46
Pump Stations	N/A	N/A	46.06(4)	N/A	46.06(4)	N/A	46.06(4)
New Sewer lines along flood barriers inside	27.86	N/A	44.13	N/A	44.13	N/A	44.13
		Round Total =	**595**	**Round Total =**	**717**	**Round Total =**	**833**

(1) Costs estimated based on current sea level
(2) Costs estimated based on sea level rise of 2050
(3) Costs estimated based on sea level rise of 2100
(4) Pump stations costs estimated with regression equation from USACE (2011)

Table 7.2.2 Selected Flood Defense Measures and Associated Costs Based on 50-Year Recurrence Interval Flood Depths for Lavallette Borough

Selected Flood Defense Measures	Measure	Based on Current Sea Level (1)		Projected 2050 Sea Level (2)		Projected 2100 Sea Level (3)	
	Length (mile)	Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)
Constructing new metal sheet bulkhead with or without movable panel	0.84	5.02	3.30	6.52	3.46	8.52	3.69
Increasing bulkhead height with or without movable panel	1.54	4.74	3.16	6.24	4.38	8.24	6.01
Sluice Gate or In-Water Mobile Barrier	0.05	N/A	13.63	N/A	15.27	N/A	17.46
Flap Gate/Check Valves	N/A	N/A	0.06	N/A	0.06	N/A	0.06
Pump Stations	N/A	N/A	10.22	N/A	10.22	N/A	10.22
New Sewer lines along flood barriers inside	2.38	N/A	3.77	N/A	3.77	N/A	3.77
		Round Total =	**35**	**Round Total =**	**38**	**Round Total =**	**42**

Table 7.2.3 Selected Flood Defense Measures and Associated Costs Based on 50-Year Recurrence Interval Flood Depths for Seaside Heights Borough

Selected Flood Defense Measures	Measure	Based on Current Sea Level (1)		Projected 2050 Sea Level (2)		Projected 2100 Sea Level (3)	
	Length (mile)	Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)
Constructing new metal sheet bulkhead with or without movable panel	0.76	4.19	2.88	5.69	3.03	7.69	3.23
Constructing new concrete flood wall with or without movable panel	0.79	7.59	1.68	9.09	1.90	11.09	2.32
Sluice Gate or In-Water Mobile Barrier	0.02	N/A	21.83	N/A	24.37	N/A	27.75
Flap Gate/Check Valves	N/A	N/A	0.02	N/A	0.02	N/A	0.02
Pump Stations	N/A	N/A	7.39	N/A	7.39	N/A	7.39
New Sewer lines along flood barriers inside	1.55	N/A	2.46	N/A	2.46	N/A	2.46
		Round Total =	**36**	**Round Total =**	**40**	**Total =**	**43**

7.3 Cost Estimation Based on 100-Year Recurrence Interval Coastal Flood Depths

Similarly, the estimated costs for Toms River Township, Lavallette Borough, and Seaside Heights Borough based on 100-year coastal flood, coupled with the current sea level, as well as 2050 and 2100 sea level rises, are shown in Tables 7.3.1, 7.3.2, and 7.3.3, respectively.

Table 7.3.1 Selected Flood Defense Measures and Associated Costs Based on 100-Year Recurrence Interval Flood Depths for Toms River Township

Selected Flood Defense Measures	Measure Length (mile)	Based on Current Sea Level (1)		Projected 2050 Sea Level (2)		Projected 2100 Sea Level (3)	
		Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)
Constructing new metal sheet bulkhead with or without movable panel	5.14	5.98	20.84	7.48	21.86	9.48	23.21
Constructing new concrete flood wall with or without movable panel	0.21	4.04	0.26	5.54	0.35	7.54	0.46
Increasing bulkhead height with or without movable panel	18.77	5.56	52.71	7.06	67.57	9.06	87.39
Constructing new levee / dike	3.77	6.00	79.58	7.50	119.38	9.50	159.17
Constructing movable or removal flood panel	1.85	2.99	1.46	4.49	2.19	6.49	3.16
Sluice Gate or In-Water Mobile Barrier	1.09	N/A	440.62	N/A	488.92	N/A	553.31
Flood Gate	0.02	N/A	0.75	N/A	0.75	N/A	0.75
Flap Gate/Check Valves	N/A	N/A	0.53	N/A	23.46	N/A	23.46
Pump Stations	N/A	N/A	47.95(4)	N/A	47.95(4)	N/A	47.95(4)
New Sewer lines along flood barriers inside	29.74	N/A	47.11	N/A	47.11	N/A	47.11
		Round Total =	**692**	**Round Total =**	**820**	**Round Total =**	**946**

(1) Costs estimated based on current sea level
(2) Costs estimated based on sea level rise of 2050
(3) Costs estimated based on sea level rise of 2100
(4) Pump stations costs estimated with regression equation from USACE (2011)

Table 7.3.2 Selected Flood Defense Measure and Associated Costs Based on 100-Year Recurrence Interval Flood Depths for Lavallette Borough

Selected Flood Defense Measures	Measure Length (mile)	Based on Current Sea Level (1)		Projected 2050 Sea Level (2)		Projected 2100 Sea Level (3)	
		Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)
Constructing new metal sheet bulkhead with or without movable panel	0.84	5.43	3.33	6.93	3.49	8.93	3.71
Increasing bulkhead height with or without movable panel	1.54	5.48	3.98	6.98	3.98	8.98	6.83
Sluice Gate or In-Water Mobile Barrier	0.05	N/A	16.50	N/A	18.35	N/A	20.81
Flap Gate/Check Valves	N/A	N/A	0.06	N/A	0.06	N/A	0.06
Pump Stations	N/A	N/A	11.21	N/A	11.21	N/A	11.21
New Sewer lines along flood barriers inside	2.38	N/A	3.77	N/A	3.77	N/A	3.77
		Round Total =	**39**	**Round Total =**	**41**	**Round Total =**	**46**

Table 7.3.3 Selected Flood Defense Measure and Associated Costs Based on 100-Year Recurrence Interval Flood Depths for Seaside Heights Borough

Selected Flood Defense Measures	Measure Length (mile)	Based on Current Sea Level (1)		Projected 2050 Sea Level (2)		Projected 2100 Sea Level (3)	
		Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)	Ave. Wat. Depth (feet)	Cost (million)
Constructing new metal sheet bulkhead with or without movable panel	0.76	5.14	2.98	6.64	3.13	8.64	3.33
Constructing new concrete flood wall with or without movable panel	0.79	10.69	2.24	12.19	2.55	14.19	2.97
Sluice Gate or In-Water Mobile Barrier	0.02	N/A	23.93	N/A	26.62	N/A	30.20
Flap Gate/Check Valves	N/A	N/A	0.02	N/A	0.02	N/A	0.02
Pump Stations	N/A	N/A	8.33	N/A	8.33	N/A	8.33
New Sewer lines along flood barriers inside	1.55	N/A	1.20	N/A	1.20	N/A	1.20
		Round Total =	**40**	**Round Total =**	**42**	**Total =**	**47**

7.4 Summary of Estimated Total Costs

The estimated total costs, based on the selected major flood defense measure components, for Toms River Township, Lavallette Borough, and Seaside Heights Borough are calculated for three recurrence interval storm depths (Tables 7.4.1, 7.4.2 and 7.4.3). The estimated total costs for each flood defense measure category are also calculated (Tables 7.1.1 to 7.3.3).

Table 7.4.1 Estimated Total Costs for Toms River TWP

	Estimated Total Costs (million) Based on the Different Flood Frequencies		
	10 - Year Coastal Flood	50 - Year Coastal Flood	100 - Year Coastal Flood
Based on Current Sea Level	385	595	692
Based on 2050 Sea Level Rise	477	717	820
Based on 2100 Sea Level Rise	564	833	946

Table 7.4.2 Estimated Total Costs for Lavallette Borough

	Estimated Total Costs (million) Based on the Different Flood Frequencies		
	10 - Year Coastal Flood	50 - Year Costal Flood	100 - Year Coastal Flood
Based on Current Sea Level	26	35	39
Based on 2050 Sea Level Rise	28	38	41
Based on 2100 Sea Level Rise	31	42	46

Table 7.4.3 Estimated Total Costs for Seaside Heights Borough

	Estimated Total Costs (million) Based on the Different Flood Frequencies		
	10 - Year Coastal Flood	50 - Year Coastal Flood	100 - Year Coastal Flood
Based on Current Sea Level	23	36	40
Based on 2050 Sea Level Rise	25	40	42
Based on 2100 Sea Level Rise	28	43	47

VIII GREEN INFRASTRUCTURE DEPLOYMENT

The detailed methodology for green infrastructure deployment is provided in Appendix F. The obtained results are summarized as follows.

8.1 Considering the Entire Area of a Town's Potential to Be Converted to Green Infrastructure

Because the input to the developed software is the amount of desirable runoff removal, the associated amount of runoff for storm rainfalls with different return periods must be determined. Given runoff values for 1- and 2-year storm event rainfalls, a land-use map and associated impermeable vale is applied to find the generated runoff for 1- and 2-year storm rainfalls (Table 8.1).

Table 8.1 Runoff and Rainfall Table for Geographic Areas under Research

	Rainfall amount(1-Year Storm) inches	Rainfall amount(2-Year Storm) inches	Runoff from 1 year storm (in)	Runoff from 2 year storm (in)	Total area (ft^2)
Point Pleasant	3	3.4	1.94	2.31	117089280
Brick Township	3	3.4	1.98	2.35	903538944
Seaside Heights	3	3.4	2.07	2.44	20351232
Stafford	3	3.4	1.9	2.26	1524948480
Toms River	3	3.4	1.98	2.35	1469191680
Little Egg Harbor	3	3.4	1.94	2.31	2045438208

Results (minimum cost and optimal combination of green infrastructures) for each geographic area are presented in the following section. Cost includes the initial capital cost, replacement cost and yearly maintenance cost. However, according to planning time horizons that are selected (10 year and 50 year) no green infrastructure is replaced. In addition, for each town the cost ratio of green to gray infrastructures is calculated.

The criterion to define the runoff removal goal is to prevent approximately 90% of rainfall events from producing any flooding. According to similar precipitation in New Jersey, Bergen County is selected as a representative area as a representative. From the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) database [[1]], 149 rainfall events are recorded for Bergen County

[1] http://www.cocorahs.org/

during the time period of 7-1-2013 to 7-1-2014 and only 8 of these events produce a runoff of more than 1 inch. Hence, by implementing the Green Infrastructure such that 1 inch of runoff can be eliminated, more than 90% of the rainfall events will never produce any flooding in the region.

1) Point Pleasant

Table 8.2 Maximum runoff removal and associated cost by converting all potential areas to green infrastructure

Maximum runoff removal by converting all potential areas to green (inches)	3.3
1 year storm : runoff removal percentage by converting all potential areas to green	170*
2 year storm : runoff removal percentage by converting all potential areas to green	142*
Cost ($) – 10 year	920,191,336
Cost ($) – 50 year	1,087,450,768

*The 170% or 142% runoff removal means that the total generated runoff could be removed by full capacity implementation of green infrastructure and on top of that, the green infrastructure has the potential to remove additional 70% or 42% of generated runoff.

Table 8.3 Optimal combination of green infrastructure and associated cost to remove 1 inch of runoff

	Optimal area (ft^2) for 1 inch runoff removal	**Maximum potential area (ft^2)**
Green roof	0	16445715
Swales	0	2284051
Planter box	164456	164457
Vegetated filter strips	2284051	2284051
Permeable sidewalk	1223685	2855065
Permeable driveway	21369676	65433350
Permeable parking	1027502	2153973
Rain garden	822285	822285
Total cost ($) – 10 year	207,830,458	
Total cost ($) – 50 year	258,382,430	

Table 8.4 Comparison of costs of green and gray infrastructure

Time Horizon	Gray Infrastructure Cost ($)	Gray Infrastructure /Green Infrastructure cost
10 year	239951913	1.15
50 year	279672065	1.08

2) Brick Township

Table 8.5 Maximum runoff removal and associated cost by converting all potential areas to green infrastructure

Maximum runoff removal by converting all potential areas to green (inches)	1
1 year storm : runoff removal percentage by converting all potential areas to green	51
2 year storm : runoff removal percentage by converting all potential areas to green	42
Cost ($) – 10 year	3,136,159,291
Cost ($) – 50 year	3,497,550,271

Table 8.6 Optimal combination of green infrastructure and associated cost to remove 1 inch of runoff

	Optimal area (ft^2) for 1 inch runoff removal	Maximum potential area (ft^2)
Green roof	116865746	117916489
Swales	16376747	16376747
Planter box	1179163	1179164
Vegetated filter strips	16376747	16376747
Permeable sidewalk	20470942	20470942
Permeable driveway	15444085	15444085
Permeable parking	15444085	15444085
Rain garden	5895820	5895820
Total cost ($) – 10 year	3,136,159,291	
Total cost ($) – 50 year	3,497,550,271	

Table 8.7 Comparison of costs of green and gray infrastructure

Time Horizon	Gray Infrastructure Cost ($)	Gray Infrastructure /Green Infrastructure cost
10 year	2075044336	0.66
50 year	2637249333	0.75

3) Seaside Heights

Table 8.8 Maximum runoff removal and associated cost by converting all potential areas to green infrastructure

Maximum runoff removal by converting all potential areas to green (inches)	1.2
1 year storm : runoff removal percentage by converting all potential areas to green	57
2 year storm : runoff removal percentage by converting all potential areas to green	49
Cost ($) – 10 year	79,606,296
Cost ($) – 50 year	89,525,239

Table 8.9 Optimal combination of green infrastructure and associated cost to remove 1 inch of runoff

	Optimal area (ft^2) for 1 inch runoff removal	Maximum potential area (ft^2)
Green roof	1760793	2803812
Swales	389405	389405
Planter box	28038	28038
Vegetated filter strips	389405	389405
Permeable sidewalk	486757	486757
Permeable driveway	1115487	1115487
Permeable parking	367228	367228
Rain garden	140190	140190
Total cost ($) – 10 year	60,247,261	
Total cost ($) – 50 year	68,558,326	

Table 8.10 Comparison of costs of green and gray infrastructures

Time Horizon	Gray Infrastructure Cost ($)	Gray Infrastructure /Green Infrastructure cost
10 year	44282721	0.73
50 year	55188406	0.80

4) Stafford

Table 8.11 Maximum runoff removal and associated cost by converting all potential areas to green infrastructure

Maximum runoff removal by converting all potential areas to green (inches)	1.2
1 year storm : runoff removal percentage by converting all potential areas to green	63
2 year storm : runoff removal percentage by converting all potential areas to green	53
Cost ($) – 10 year	5,967,231,060
Cost ($) – 50 year	6,710,455,984

Table 8.12 Optimal combination of green infrastructure and associated cost to remove 1 inch of runoff

	Optimal area (ft^2) for 1 inch runoff removal	Maximum potential area (ft^2)
Green roof	132125551	209923960
Swales	29155140	29155140
Planter box	2099239	2099239
Vegetated filter strips	29155140	29155140
Permeable sidewalk	486756	36443940
Permeable driveway	83517583	83517583
Permeable parking	27494743	27494743
Rain garden	10496198	10496198
Total cost ($) – 10 year	4,516,629,391	
Total cost ($) – 50 year	5,139,373,582	

Table 8.13 Comparison of costs of green and gray infrastructure

Time Horizon	Gray Infrastructure Cost ($)	Gray Infrastructure /Green Infrastructure cost
10 year	3123898771	0.69
50 year	3929890032	0.76

5) Toms River

Table 8.14 Maximum runoff removal and associated cost by converting all potential areas to green infrastructure

Maximum runoff removal by converting all potential areas to green (inches)	1.1
1 year storm : runoff removal percentage by converting all potential areas to green	55
2 year storm : runoff removal percentage by converting all potential areas to green	46
Cost ($) – 10 year	5,269,027,597
Cost ($) – 50 year	5,925,414,027

Table 8.15 Optimal combination of green infrastructure and associated cost to remove 1 inch of runoff

	Optimal area (ft^2) for 1 inch runoff removal	Maximum potential area (ft^2)
Green roof	145758409	185466241
Swales	25758346	25758346
Planter box	1854662	1854662
Vegetated filter strips	25758346	25758346
Permeable sidewalk	32197945	32197945
Permeable driveway	73787154	73787154
Permeable parking	24291398	24291398
Rain garden	9273310	9273310
Total cost ($) – 10 year	4,570,245,989	
Total cost ($) – 50 year	5,168,594,625	

Table 8.16 Comparison of costs of green and gray infrastructure

Time Horizon	Gray Infrastructure Cost ($)	Gray Infrastructure /Green Infrastructure cost
10 year	3276769760	0.71
50 year	4098592245	0.79

6) Little Egg Harbor

Table 8.17 Maximum runoff removal and associated cost by converting all potential areas to green infrastructure

Maximum runoff removal by converting all potential areas to green (in)	0.92
1 year storm : runoff removal percentage by converting all potential areas to green	47
2 year storm : runoff removal percentage by converting all potential areas to green	39
Cost ($) – 10 year	6,140,269,847
Cost ($) – 50 year	6,904,530,518

Table 8.18 Optimal combination of green infrastructure and associated cost to remove 0.92 inch of runoff

	Optimal area (ft^2) for 0.92 inch runoff removal	Maximum potential area (ft^2)
Green roof	215573574	215573574
Swales	29939781	29939781
Planter box	2155735	2155735
Vegetated filter strips	29939781	29939781
Permeable sidewalk	37424742	37424742
Permeable driveway	85765261	85765261
Permeable parking	28234699	28234699
Rain garden	10778675	10778675
Total cost ($) – 10 year	6,140,269,847	

Total cost ($) – 50 year	6,904,530,518	

Table 8.19 Comparison of costs of green and gray infrastructure

Time Horizon	Gray Infrastructure Cost ($)	Gray Infrastructure /Green Infrastructure cost
10 year	4337829967	0.7
50 year	5446390531	0.78

8.2 Consideration of Potential Areas of Towns within 100-year Coastal Flood Zone to Be Converted to Green

The developed areas in the 100 year recurrence interval storm water elevation are considered to undergo a change in land use. From the land use map, areas such as wetlands, forests, water bodies and agricultural lands are excluded from the calculation. Using land use classification of the areas of commercial, industrial, residential, athletic fields, urban lands and built up lands, these areas are considered for green infrastructure implementation. The characteristics of the areas in 100-year storm in the towns under study are characterized (Table 8.20).

Table 8.20 Characteristics of the areas within 100-year coastal flood zone in under-study towns

	Rainfall amount (1-Year Storm) (in)	Runoff from 1 year storm (in)	Total area (sq.ft)	Area in 100 year flood zone (sq.ft)	Excluded area (sq.ft)	Area used for analysis (sq.ft)	Percentage of area in the town
Point Pleasant	3	1.95	117089280	61410811	26081309	35329502	30
Brick Township	3	1.78	903538944	349841184	262020556	87820628	10
Seaside Heights	3	2.23	20351232	14742771	8017923	6724848	33
Stafford	3	1.69	1524948480	486320062	447445416	38874646	3
Toms River	3	1.70	1469191680	328127230	210883172	117244058	8
Little Egg Harbor	3	1.91	2045438208	674207608	632258494	41949114	2

The obtained results are as below. The total cost of deploying green infrastructure is dramatically decreased for the 100-year storm zone

1) Brick Township

- Maximum runoff capture: 1.2 inch
- Cost to remove 1.2 inch of runoff (10 year horizon) = $ 353,027,084
- Cost to remove 1.2 inch of runoff (50 year horizon) = $ 394,491,537

Table 8.21 Optimal combination of green infrastructure and associated cost to remove 1 inch of runoff

	Optimal area (ft^2) for 1 inch runoff removal	Maximum potential area (ft^2)
Green roof	8277559	13348735
Swales	2502887	2502887
Planter box	133487	133487
Vegetated filter strips	2502887	2502887
Permeable sidewalk	2335150	2335150
Permeable driveway	2836606	2836606
Permeable parking	852738	852738
Rain garden	667436	667436
Total cost ($) – 10 year	269,488,033	
Total cost ($) – 50 year	304,014,092	

Table 8.22 Comparison of costs of green and gray infrastructure

Time Horizon	Gray Infrastructure Cost ($)	Gray Infrastructure /Green Infrastructure cost
10 year	201737716	0.74
50 year	274468775	0.90

2) Point Pleasant

- Maximum runoff capture: 1.2 inch
- Cost to remove 1.2 inch of runoff (10 year horizon) = $ 142,473,173
- Cost to remove 1.2 inch of runoff (50 year horizon) = $ 159,133,719

Table 8.23 Optimal combination of green infrastructure and associated cost to remove 1 inch of runoff

	Optimal area (ft^2) for 1 inch runoff removal	Maximum potential area (ft^2)
Green roof	3363292	5370084
Swales	1006890	1006890
Planter box	53701	53701
Vegetated filter strips	1006890	1006890
Permeable sidewalk	939411	939411
Permeable driveway	1141142	1141142
Permeable parking	343049	343049
Rain garden	251855	251855
Total cost ($) – 10 year	108,866,113	
Total cost ($) – 50 year	122,735,401	

Table 8.24 Comparison of costs of green and gray infrastructure

Time Horizon	Gray Infrastructure Cost ($)	Gray Infrastructure /Green Infrastructure cost
10 year	81420628	0.74
50 year	110758812	0.90

3) Seaside Heights

- Maximum runoff capture: 1.2 inch
- Cost to remove 1.2 inch of runoff (10 year horizon) = $ 27,168,703
- Cost to remove 1.2 inch of runoff (50 year horizon) = $ 30,341,316

Table 8.25 Optimal combination of green infrastructure and associated cost to remove 1 inch of runoff

	Optimal area (ft^2) for 1 inch runoff removal	Maximum potential area (ft^2)
Green roof	645217	1022176
Swales	191658	191658
Planter box	10221	10221
Vegetated filter strips	191658	191658
Permeable sidewalk	174412	174412
Permeable driveway	211866	211866
Permeable parking	63691	63691
Rain garden	51105	51105
Total cost ($) – 10 year	20,771,715	
Total cost ($) – 50 year	23,413,023	

Table 8.26 Comparison of costs of green and gray infrastructure

Time Horizon	Gray Infrastructure Cost ($)	Gray Infrastructure /Green Infrastructure cost
10 year	15474172	0.74
50 year	21062586	0.89

4) Stafford

- Maximum runoff capture: 1.2 inch
- Cost to remove 1.2 inch of runoff (10 year horizon) = $ 156,270,857
- Cost to remove 1.2 inch of runoff (50 year horizon) = $ 174,625,495

Table 8.27 Optimal combination of green infrastructure and associated cost to remove 1 inch of runoff

	Optimal area (ft^2) for 1 inch runoff removal	Maximum potential area (ft^2)
Green roof	3664143	5908946
Swales	1107927	1107927
Planter box	59089	59089
Vegetated filter strips	1107927	1107927
Permeable sidewalk	1033676	1033676
Permeable driveway	1255651	1255651
Permeable parking	377472	377472
Rain garden	295447	295447
Total cost ($) – 10 year	119,291,492	
Total cost ($) – 50 year	134,574,783	

Table 8.28 Comparison of costs of green and gray infrastructure

Time Horizon	Gray Infrastructure Cost ($)	Gray Infrastructure /Green Infrastructure cost
10 year	89301148	0.74
50 year	121496253	0.90

5) Toms River

- Maximum runoff capture: 1.2 inch
- Cost to remove 1.2 inch of runoff (10 year horizon) = $ 471,305,409
- Cost to remove 1.2 inch of runoff (50 year horizon) = $ 526,662,109

Table 8.29 Optimal combination of green infrastructure and associated cost to remove 1 inch of runoff

	Optimal area (ft^2) for 1 inch runoff removal	Maximum potential area (ft^2)
Green roof	11050880	17821096
Swales	3341455	3341455
Planter box	178210	178210
Vegetated filter strips	3341455	3341455
Permeable sidewalk	3117519	3117519
Permeable driveway	3786983	3786983
Permeable parking	1138439	1138439
Rain garden	891050	891050
Total cost ($) – 10 year	359,777,427	
Total cost ($) – 50 year	405,871,093	

Table 8.30 Comparison of costs of green and gray infrastructure

Time Horizon	Gray Infrastructure Cost ($)	Gray Infrastructure /Green Infrastructure cost
10 year	269327992	0.74
50 year	366426885	0.90

6) Little Egg Harbor

- Maximum runoff capture: 1.2 inch
- Cost to remove 1.2 inch of runoff (10 year horizon) = $ 168,629,797
- Cost to remove 1.2 inch of runoff (50 year horizon) = $ 188,436,041

Table 8.31 Optimal combination of green infrastructure and associated cost to remove 1 inch of runoff

	Optimal area (ft^2) for 1 inch runoff removal	Maximum potential area (ft^2)
Green roof	3953927	6376265
Swales	1195550	1195550
Planter box	63762	63762
Vegetated filter strips	1195550	1195550
Permeable sidewalk	1115426	1115426
Permeable driveway	1354956	1354956
Permeable parking	407325	407325
Rain garden	318813	318813
Total cost ($) – 10 year	128,725,855	
Total cost ($) – 50 year	145,217,850	

Table 8.32 Comparison of costs of green and gray infrastructure

Time Horizon	Gray Infrastructure Cost ($)	Gray Infrastructure /Green Infrastructure cost
10 year	96363672	0.74
50 year	131104980	0.90

IX SUMMARY

In this study, based on the flood data and coupled with topographical analysis, the locations and boundaries of the vulnerable populations and properties along Barnegat Bay have been identified. Based on interview and field investigation, the existing flood problems and existing flood defense measures were also identified and evaluated.

For each specific field condition, in terms of topographical analysis and flood data, the selection and placement of various flood reduction alternatives have been indicated on maps and listed in their related tables, including the various quantities, such as flood defense measure length and average water depth. The water protection levels used for the placement of flood defense measures include 10-year, 50-year, and 100-year recurrence interval coastal flood elevations, plus the sea level rise.

Besides the pumping to relieve the stormwater drainage-related flooding, the option of deploying stormwater green infrastructure to reduce the runoff produced by rainfall is also explored.

For Barnegat Bay, most of the areas along water bodies have bulkheads installed. The existing bulkheads are too low to defend against the projected future flood elevations. Increasing the bulkhead height, with or without movable panels, is proposed in this study. In term of the social, environmental, and financial concerns, two new types of movable flood walls are presented.

Moreover, during extreme weather conditions, such as Superstorm Sandy, the power supply systems may be seriously damaged, and the pumping stations may not work. Therefore, to solve this problem, six new types of pumps driven by green energies are presented in this study.

This study focuses on some possible engineering solutions options. Some other options as well as the environmental impacts of the proposed options are evaluated elsewhere.

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APPENDICES

Appendix A Threat of Sea Level Rise

A1 Point Pleasant Boro. (including Point Pleasant Beach Borough, and Bay Head Borough)

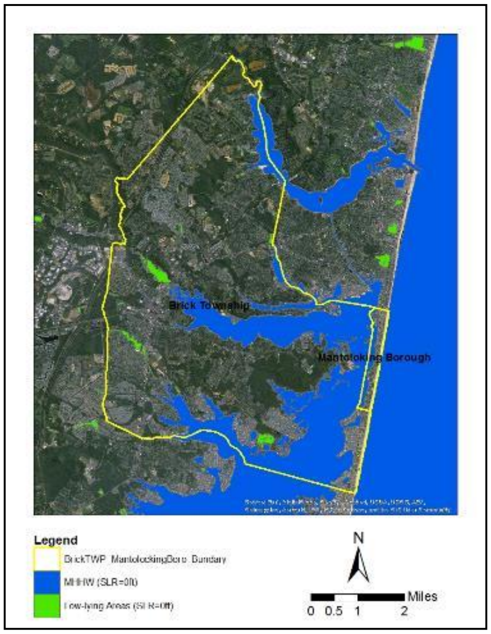
(a) MHHW (SLR = 0 ft)

(b) SLR = 1 ft

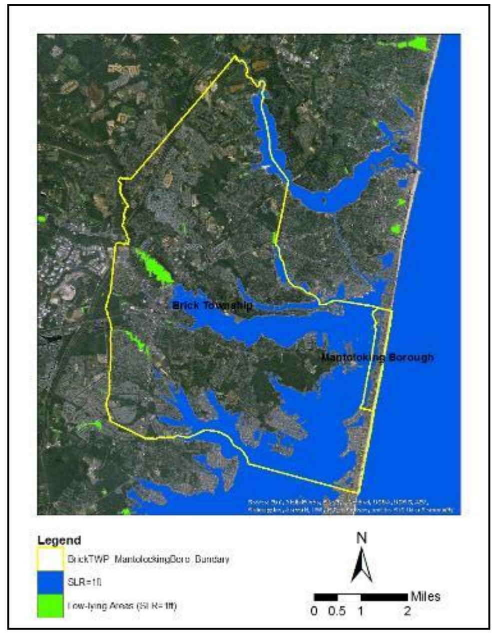
(c) SLR = 2 ft

(d) SLR = 3 ft

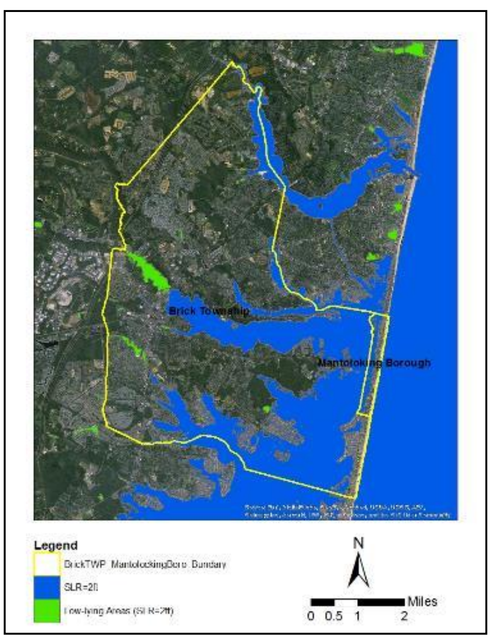
A2 **Brick Township** (including Mantoloking Borough)



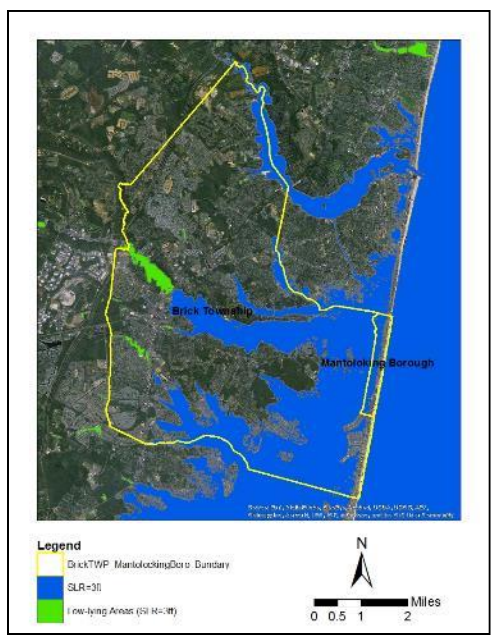
(a) MHHW (SLR = 0 ft)



(b) SLR = 1 ft

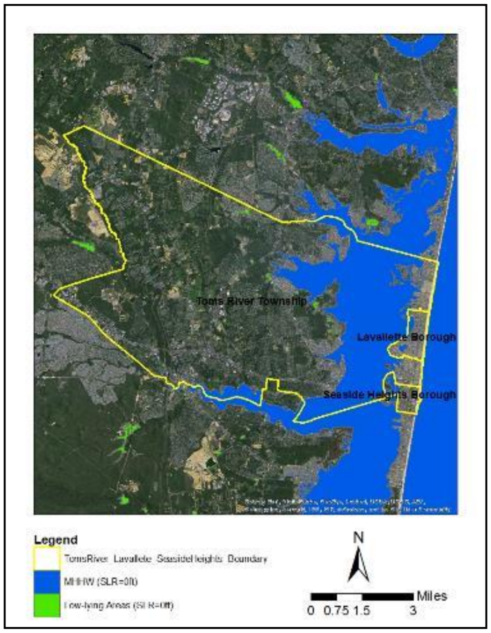


(c) SLR = 2 ft

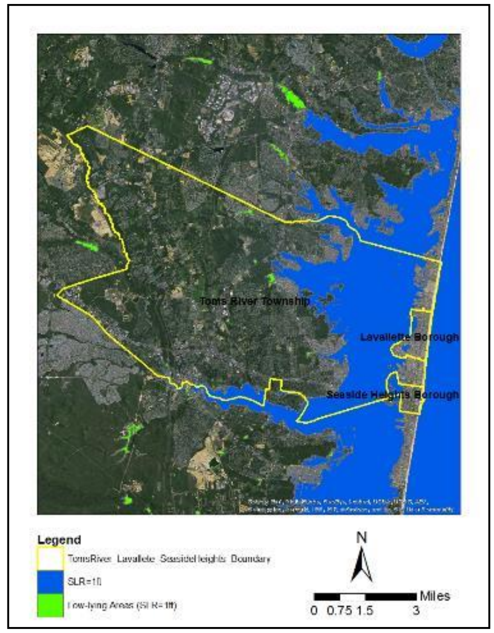


(d) SLR = 3 ft

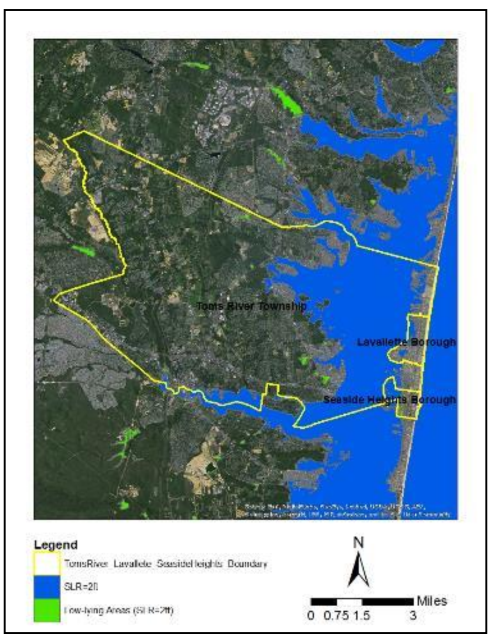
A3 Toms River Township and Seaside Heights Borough (including Lavallette Borough)



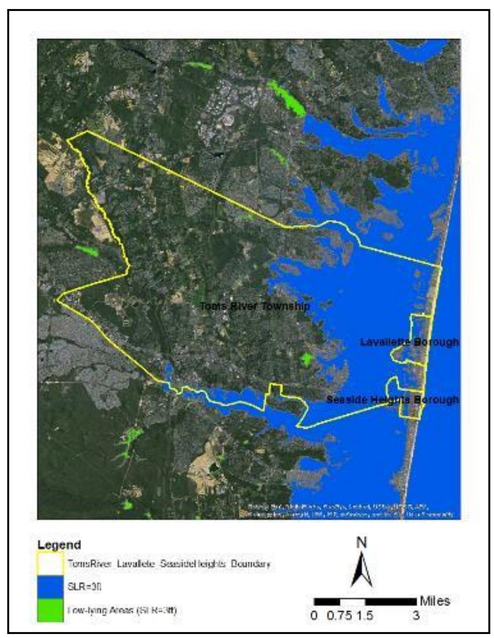
(a) MHHW (SLR = 0 ft)



(b) SLR = 1 ft

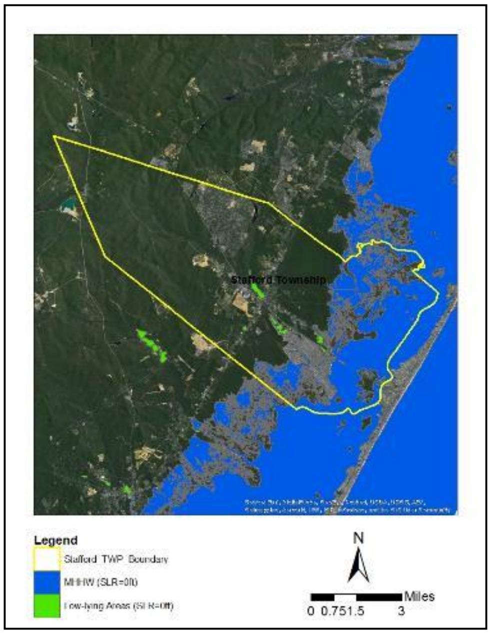


(c) SLR = 2 ft

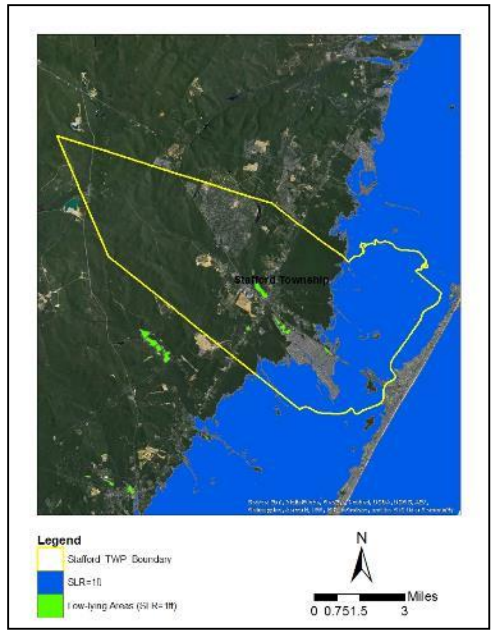


(d) SLR = 3 ft

A4 Stafford Township

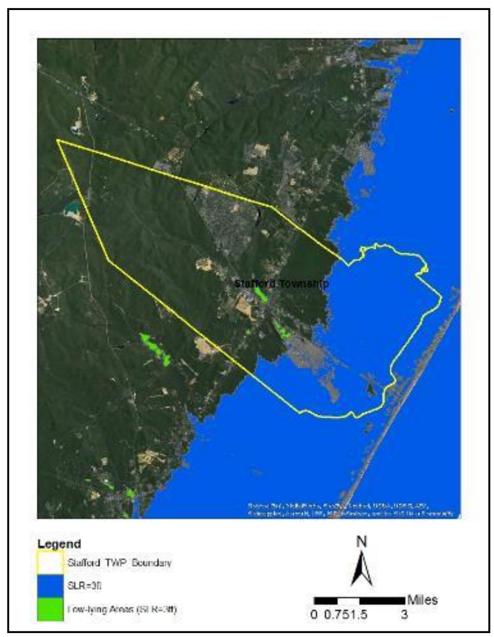


(a) MHHW (SLR = 0 ft)



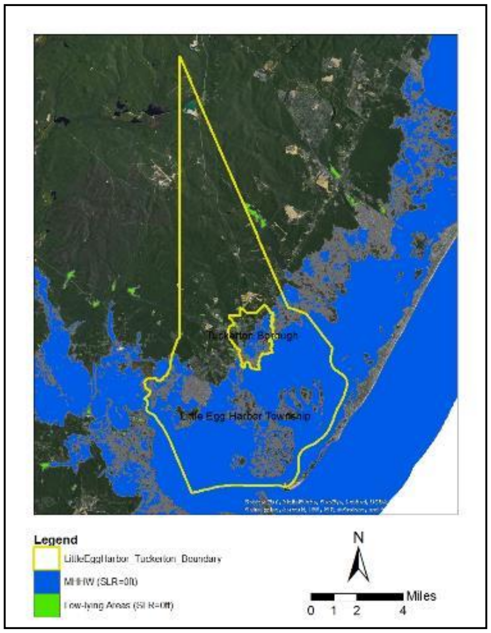
(b) SLR = 1 ft

(c) SLR = 2 ft

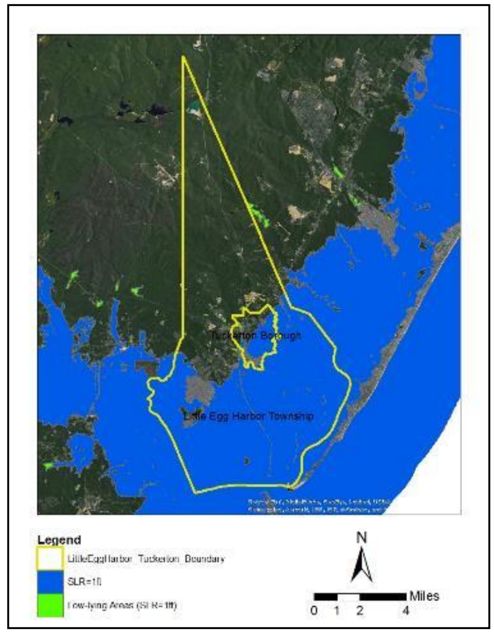


(d) SLR = 3 ft

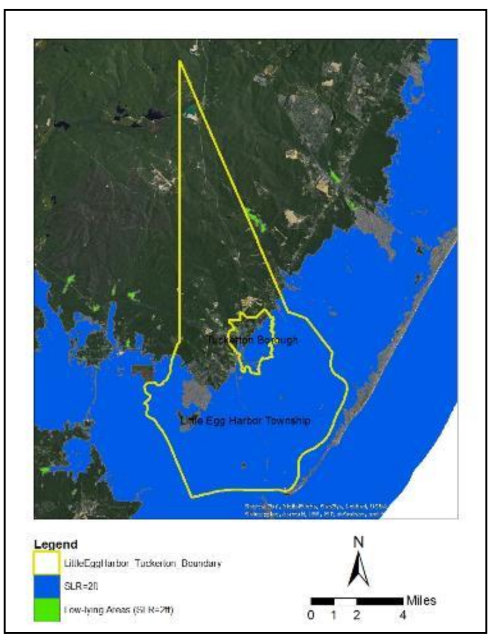
A5 Little Egg Harbor Township (including Tuckerton Borough)



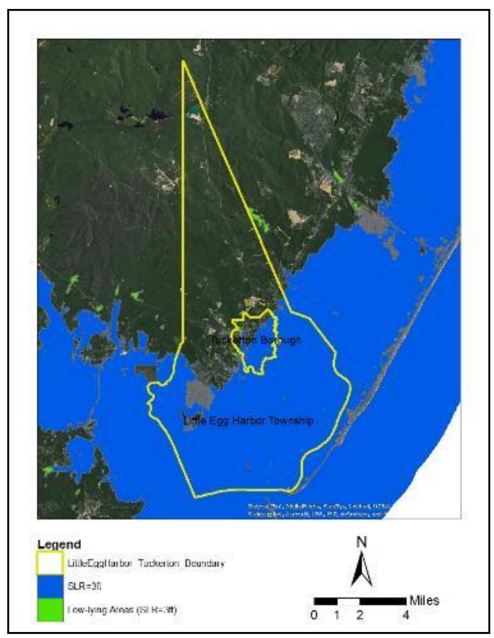
(a) MHHW (SLR = 0 ft)



(b) SLR = 1 ft



(c) SLR = 2 ft



(d) SLR = 3 ft

Appendix B Summary of Available Flood Defense Measures

In terms of the spatial scale and the functionality of each flood defense product, the currently used flood defense measures are organized and classified into three categories:

- Flood defense measures used by the private, public, and utilities sectors
- Flood defense measures in place at coast, bay, and river sites
- Others, such as marsh restoration

For each category, several of the currently used flood defense measures are described. The full list of the existing flood defense measures are provided in Appendix B.

B.1 Flood Defense Measures Used by Private, Public, and Utilities Sectors

1) Sandbags

One measure used for flood defense is the deployment of sandbags (Fig. B.1a). Sandbags can be used as an emergence or temporary flood defense for homes or businesses or along river banks. They create a barrier to divert water away from a protected area. Advantages of traditional sandbags are that they are inexpensive and easy to store. Disadvantages are that they are very heavy, making it difficult to transport and maneuver, and they are susceptible to rot.

Sandless sandbags are a viable alternative to sandbags (Fig. B.1b). They contain polymer that absorbs floodwater to create an inflated sandbag. Similar to traditional sandbags, they divert water away from a protected site. The main advantage is their lightweight and small size before absorbing water. A main drawback is their expensive price.

(a) Traditional Sandbags
(http://news.bbc.co.uk/2/hi/in_pictures/7072725.stm)

(b) Self Inflating Sandbags-Aqua-Sac
(Sources: http://www.flood-defence.co.uk)

Fig. B1 Sandbags

2) Muscle Wall

Muscle walls provide a physical containment for stormwater. The walls are designed to be anchored to the ground (Fig. B2), so that moving water does not penetrate beyond the wall. The wall requires less set up than sandbags used for the same purpose. The Muscle wall may be used to protect residential, commercial, and industrial properties, as well as hospitals, utilities, and other forms of community infrastructure (Fig. B2).

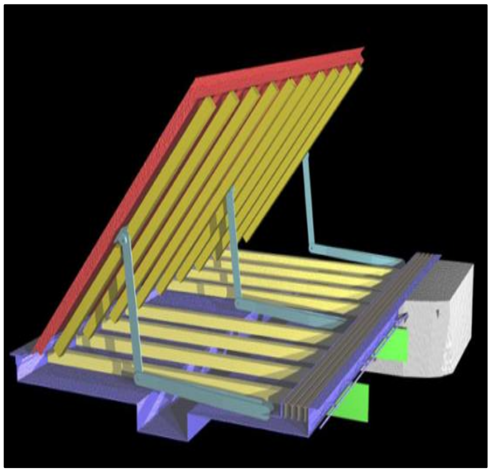
(a) Protecting Buildings

(b) Protecting Infrastructures/Utilities

Fig. B.2 Muscle Walls used to Protect Buildings and Infrastructures
(Source: http://www.musclewall.com/)

3) Automatic Floodgates

An Automatic Floodgate is a passive flood barrier system used to close vulnerable openings from being sites of flood penetration. During a flood event, it works automatically without human intervention and power. Automatic floodgate can be used for commercial, residential, industrial and infrastructure flood defense. One type of the automatic floodgate is the FloodBreak® Automatic Floodgate developed by FloodBreak. Fig. B3 shows its application for flood defense.



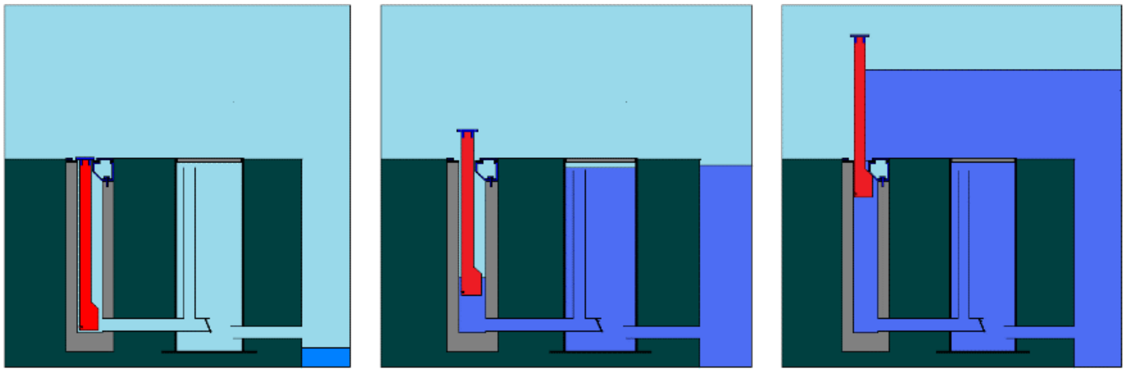
(a) FloodBreak (R) Automatic Floodgates (b) Prevent Garage Flooding

(c) Vehicle Floodgate (d) Roadway Floodgate

Fig.B3 Applications of FloodBreak$^{(R)}$ Automatic Floodgates to Prevent Flooding
(Source: http://floodbreak.com/)

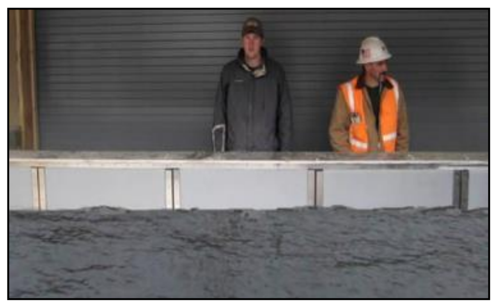
5) Self Closing Flood Barrier (SCFB)

Self-Closing Flood Barrier (SCFB), developed by Van den Noort Innovations BV (Netherlands), is an automatic flood defense system. Fig. B4 illustrates its working principle. The advantage of this system is that it works automatically without human intervention and power. The disadvantage is that this system can only be used for inland waterway floods since it is not suitable for the fluctuating water levels.



(a) Side View: Working Principle of the Self Closing Flood Barrier
(Source: http://www.noort-innovations.nl/index.html)

(b) Installation



(c) Prevent Business Building Flooding

(d) Prevent Business Area Flooding

(e) Prevent Neighborhood Flooding

Fig. B4 Applications of Self-Closing Flood Barrier to Prevent Flooding
(Source: http://www.hyflo.nl/)

6) Removable Flood Walls/Gates

The removable flood walls /gates are only erected prior to a threatened storm event. Once the flood recedes, the wall panels will be taken away without blocking the front view. One of the products in this category is Invisible Flood Control Wall (IFCW) developed by Flood Control America. Fig. B5 shows the application of IFCA for flood defense.

Fig. B5 Applications of Invisible Flood Control Wall to Prevent Flooding
Source: http://floodcontrolam.com)

7) Conventional Concrete Flood Wall

Conventional concrete floodwalls are vertical barriers to contain floodwaters. Concrete flood walls are permanent structures. They are especially useful in locations where space is scarce, and there is no height limitation. They often contain floodgates to prevent the penetrating flow of floodwaters. Disadvantages include the substantial cost and required construction space. Fig. B.6 shows two examples of the concrete flood walls for flood defense.

(Source: http://floodbreak.com)

(Source: http://www.mgeeng.com)

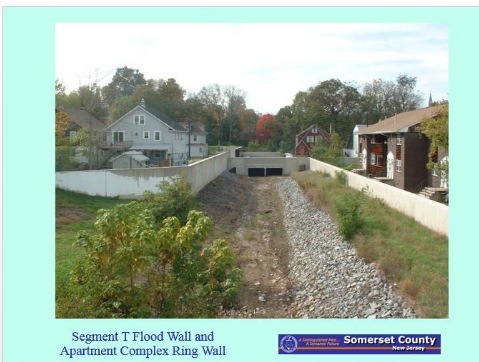


Fig. B6 Concrete Flood Walls for Flood Defense

8) Flood Gate/Closure Gate

Flood gates or closure gates, coupled with flood walls or other flood control structures, are often used to block water access to properties enclosed by flood defense structures. Fig. B7 shows an example of the application of a flood gate or closure gate to prevent flooding.

East Street closure gate http://www.nan.usace.army.mil/business/prjlinks/flooding/greenbk/

Fig.B7 Flood Gate Closure Gate (Closed Prior to a Storm Event)

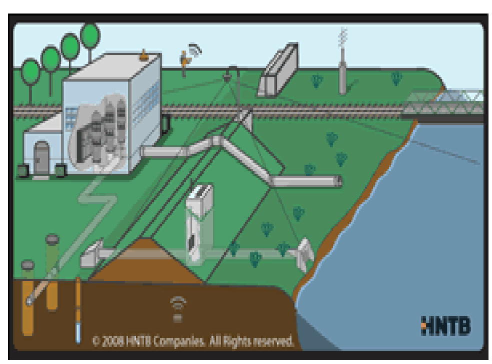
9) Earthen Levees

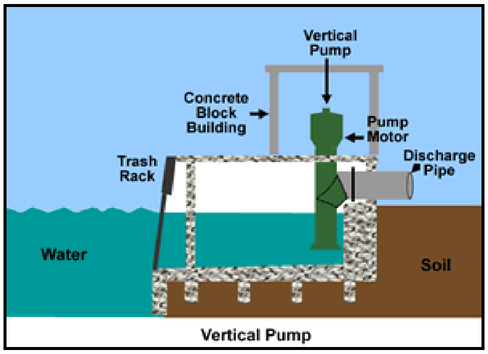
Earthen levees are often used in locations where protected properties border or are near the green space. The earthen levee surface must be covered by grass to prevent erosion. Fig. B8 shows an example of a vegetated earthen levee.

Fig. B8 Vegetated Earthen Levee

10) Pumping Stations for Flood Protection Projects

In those cases with low-lying areas, or areas enclosed by flood defense measures, if the water levels in the adjacent water bodies are higher than the inland flood water levels, then the inland flood water cannot be drained by employing gravitational method. In this case, a pumping station should be used. Fig. B9 shows an example of a pumping station located beside an earthen levee, and types of the pumps commonly used.





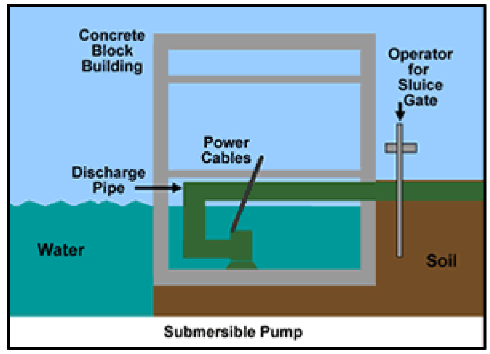


Fig. B9 Pumping Station for Flood Protection
(Source: http://library.water-resources.us/docs/MMDL/FLD/Feature.cfm?ID=16)

B.2 Flood Defense Measures in Place at Coast, Bay, and River Sites

There are several common types of flood defense structures in place along much of Barnegat Bay. They serve to restrict penetration of flood water by creating a solid barrier at the water and contact. Other measures that may also be used in these locations are presented.

1) Bulkheads

Currently, the most common flood defense measures along the waterfront (such as Barnegat Bay, Manasquan River, Point Pleasant Cannel, Beaverdam creek, Metedeconk River, Toms River, and dredged lagoons) are a bulkheaded shoreline or a series of discontinuous bulkheads. Examples of the existing bulkhead construction are shown in Fig. B10.1. The detailed bulkhead components are shown in Fig.B10.2. The bulkhead anchor methods proposed by U.S. Army Corps of Engineers are shown in Fig.B10.3.

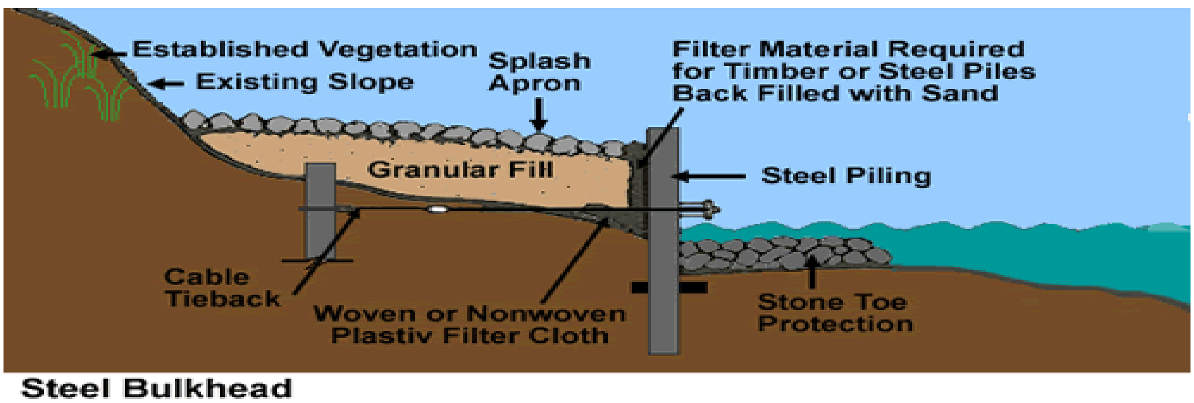
(a) Steel Bulkhead along the Pt. Pleasant Canal

(a) Steel Bulkhead along a Dredged Lagoon

(d) Steel Bulkhead Cap

(d) Wood Bulkhead

Fig. B10.1 Existing Bulkhead in Barnegat Bay



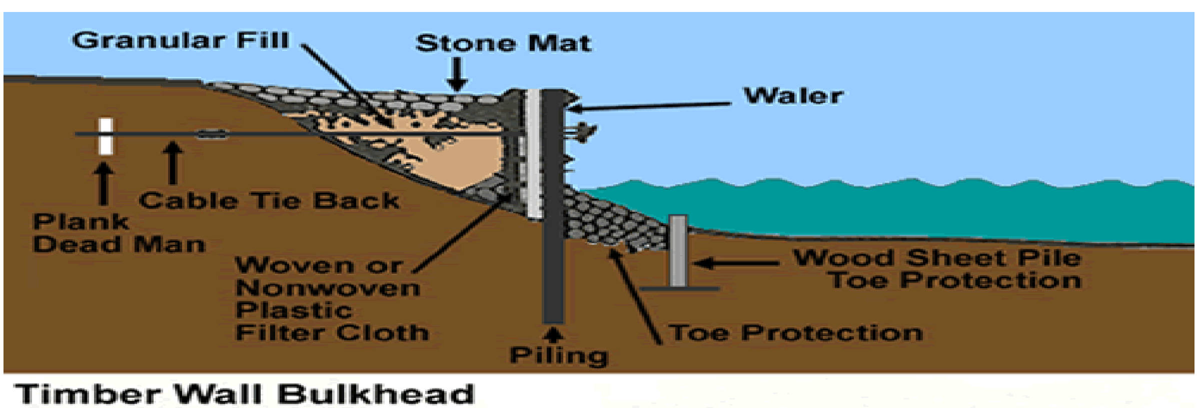
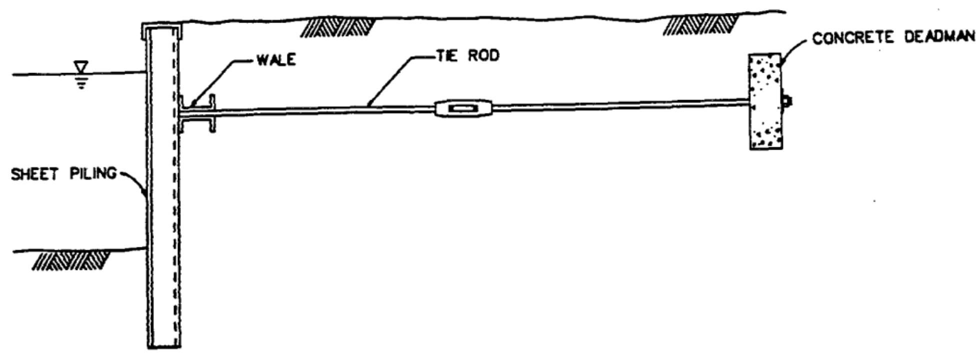
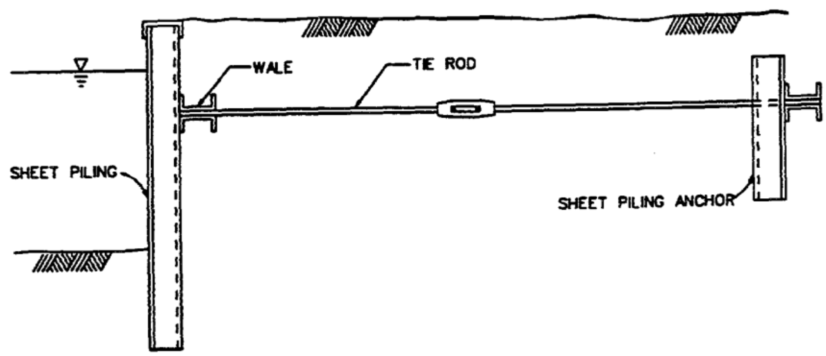


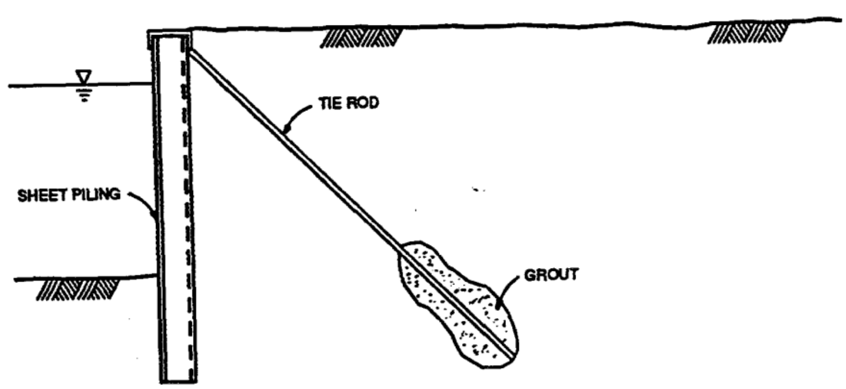
Fig. B10.2 Bulkhead Construction Components
(Source: http://library.water-resources.us/docs/MMDL/FLD/Feature.cfm?ID=34)



a. Tie rods and dead man



b. Tie rods and anchor wall



c. Tiebacks with grout anchor

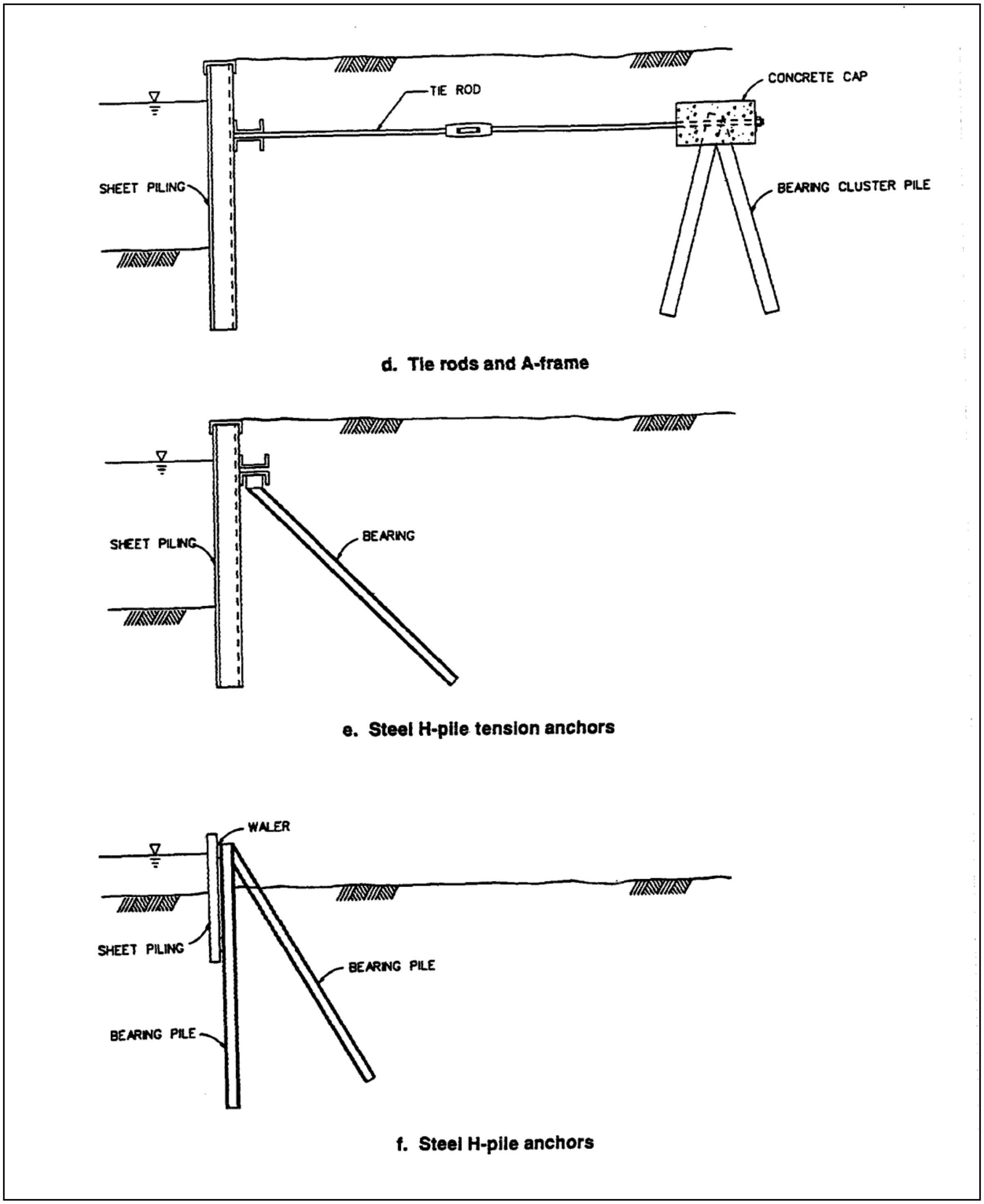
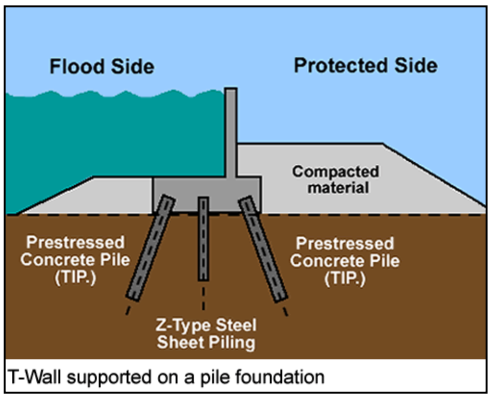


Fig. B10.3 Bulkhead Anchor Methods
(Source: U.S. Army Corps of Engineers, Engineering and Design, Manual No. 1110-2-2504)

2) Concrete Floodwalls

Concrete floodwalls are vertical barriers to restrict the penetration of floodwater. Concrete floodwalls are permanent structures. They are widely used for flood defense along various types of waterways depending on the field and environmental conditions allow. They are especially useful in locations where space is scarce, and there is no height limitation.

The two basic types of concrete floodwalls are T-Wall and I-Wall (Fig. B11.1). Fig. B11.2 shows the two basic types of floodwalls under construction. Fig. B11.3 shows a completed floodwall on an earthen levee.



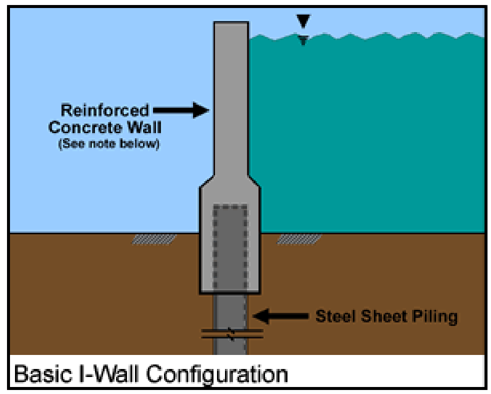


Fig. B11.1 Basic Types and Details of Floodwalls: T-Wall and I-Wall (http://library.water-resources.us/docs/MMDL/FLD/Feature.cfm?ID=2)

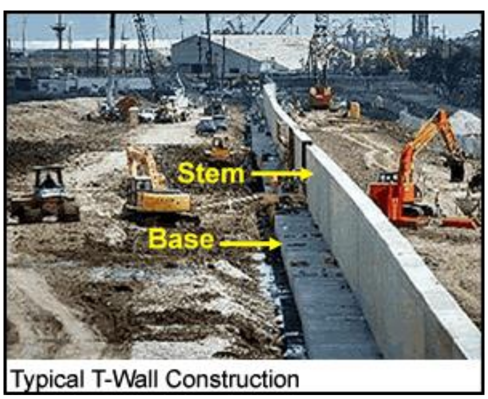


Fig. B11.2 Flood Wall Under Construction (http://library.water-resources.us/docs/MMDL/FLD/Feature.cfm?ID=2)

Fig. B11.3 Concrete Floodwalls on Earth Levees
(Source: http://www.wdsu.com/news/local-news/new-orleans/fortress-of-new-orleans-photo-tour-of-largest-civil-works-program-in-us-history/21371650)

3) Flap Gates/Flap Valves, Check Valves, and Tide Gates

Flap Gates or FlapValves are used to prevent the backflow of water through an opening. A flap gate or flap valve is installed at the outfall terminus of a pipe or culvert. When the head pressure increases downstream of the opening, the flap will seal the opening due to the increased pressure to prevent backflow. However, when the head pressure bebind the flap is higher than that downstream of the opening, the flap will open and the pipe or culvert drain. Fig. B12.1 shows a rectangular flap valve, developed by HC Watercontrol, used to prevent backflow. Rectangular and circular shapes are available from the manufacture.

Check Valve is designed for backflow prevention. A check valve is installed at the stormwater outfall to prevent the backflow. Fig. B12.2 shows one type of check valve, developed by Tideflex Technologies, that is used for backflow prevention.

Tide Gates are normally placed at the mouth of streams or small rivers. During the incoming tides, the tide gates are closed, by the difference in water level on either side of the gate, to prevent the tidal waters from moving upstream; however during outgoing tides, the tide gates are opened to allow waters to drain out via the culvert and into the estuary. Fig. B12.3 shows the working process. The tide gates were installed at West River, City of New Haven, CT.

Fig. B12.1 Flap Valve Used to Prevent Backflow
(Sources: http://www.hcwatercontrol.com/Flap-Valves)

Fig. B12.2 Check Valve Used for Backflow Prevention
(Source: http://www.tideflex.com/tf/index.php/content/view/228/368/)

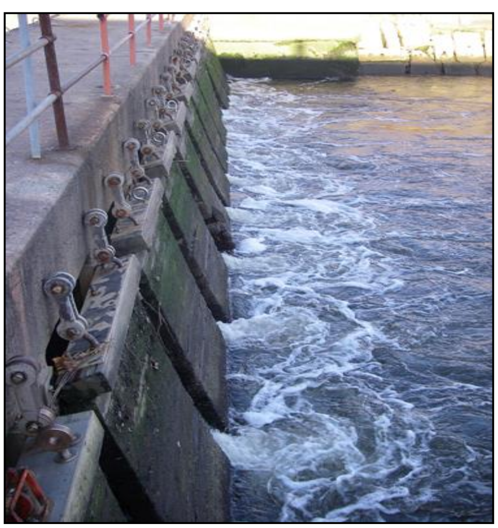


Fig. B12.3 Tide Gates at West River, City of New Haven, CT
(Sources: http://www.cityofnewhaven.com/Engineering/westriver.asp)

4) Storm Surge Barriers

Storm surge barriers are a type of floodgate designed specifically for storm surge. Storm surge barriers may be the most reliable and effective measures for coastal area flood defense. Some successful cases are in Europe, especially in The Netherlands. The surge barriers are often part of a larger scale system of dams and levees. Implementation requires a large-scale engineering project. Figs. B14.1, B14.2, B14.3, and B14.4 show a few successful cases.

Fig. B14.1 Case 1: Maeslant Storm Surge Barrier (The Netherlands, 1997)
(Source: http://rudy.negenborn.net/rudy/projects/2008-maeslant/msc_topic_maeslant.html)

Fig. B14.2 Case 2: Hartel Canal Barrier (The Netherlands, 1997)

(Source: http://www.deltawerken.com/Hartel-barrier/331.html)

Fig. B14.3 Case 3: Easter Scheldt Storm Surge Barrier (The Netherlands, 1997)
(Source: http://oceana.org/sites/default/files/explore/places/ocean119eassch_003.jpg; http://s1.hubimg.com/u/2183080_f260.jpg)

B.3 Other Measures - Salt Marsh Restoration

In Little Egg Harbor Township and Stafford Township, large areas are covered by salt marsh. Research (Anderson, etc., 2013) shows that healthy salt marsh including living shorelines along the bay or estuary edge can stabilize shorelines and protect the coasts from damage by incoming waves as well as provide for significant surge attenuation thus mitigating flood. Thus, in addition to the grey engineering approches, it is suggested that the salt marsh retoration (a green approach) be additionally performed for flood mitigation.

Appendix C 10-yr, 50-yr, and 100-yr Coastal Flood Maps

C1 Point Pleasant Borough -including Point Beach Borough and Bay Head Borough

Fig. C1.1 10-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

Fig. C1.2 50-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

Fig. C1.3 100-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

C2 BRICK TOWNSHIP- including Mantoloking Borough

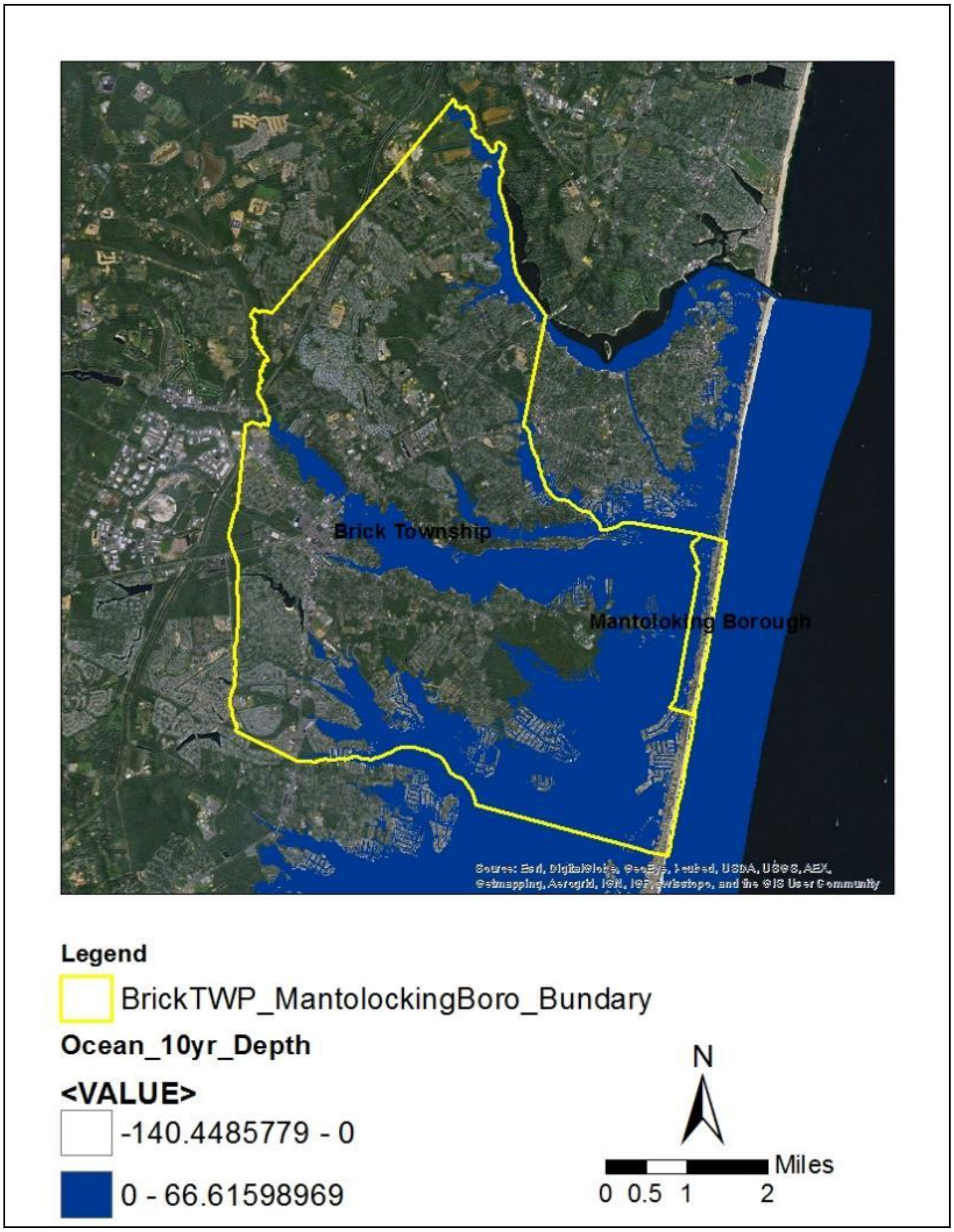


Fig. C2.1 10-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

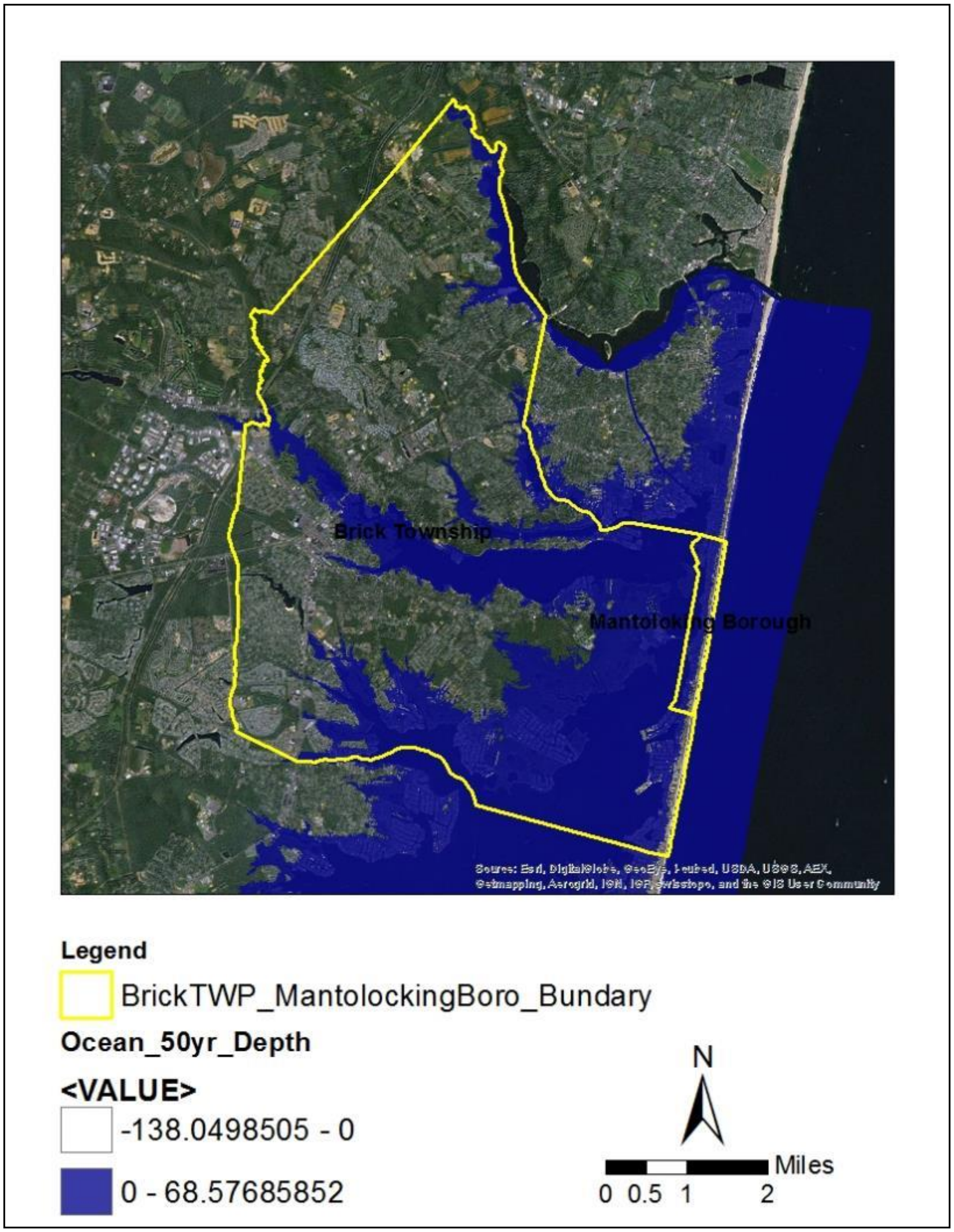


Fig. C2.2 50-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

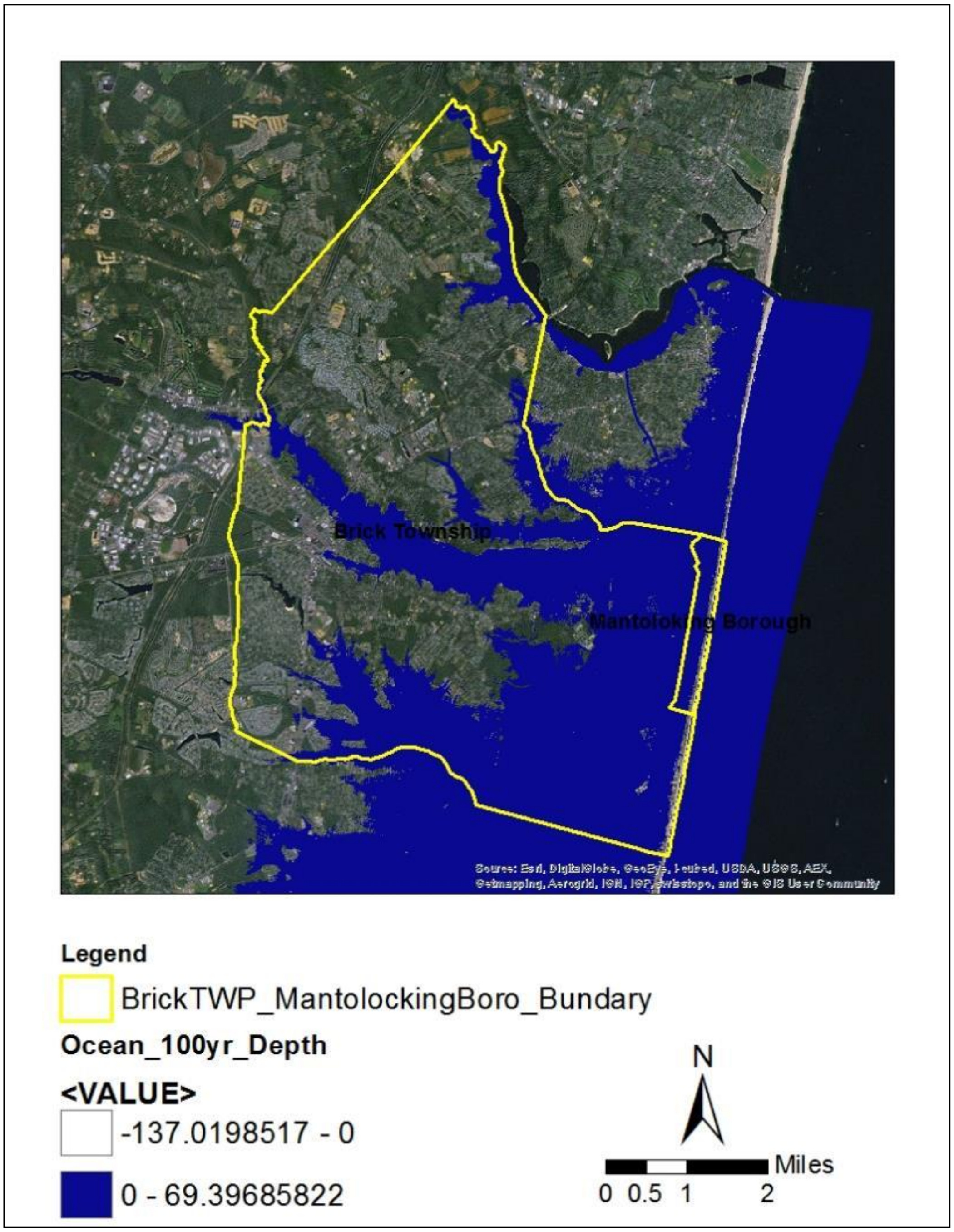


Fig. C2.3 100-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

C3 **TOMS RIVER TOWNSHIP** -including Seaside Heights and Lavallette Borough

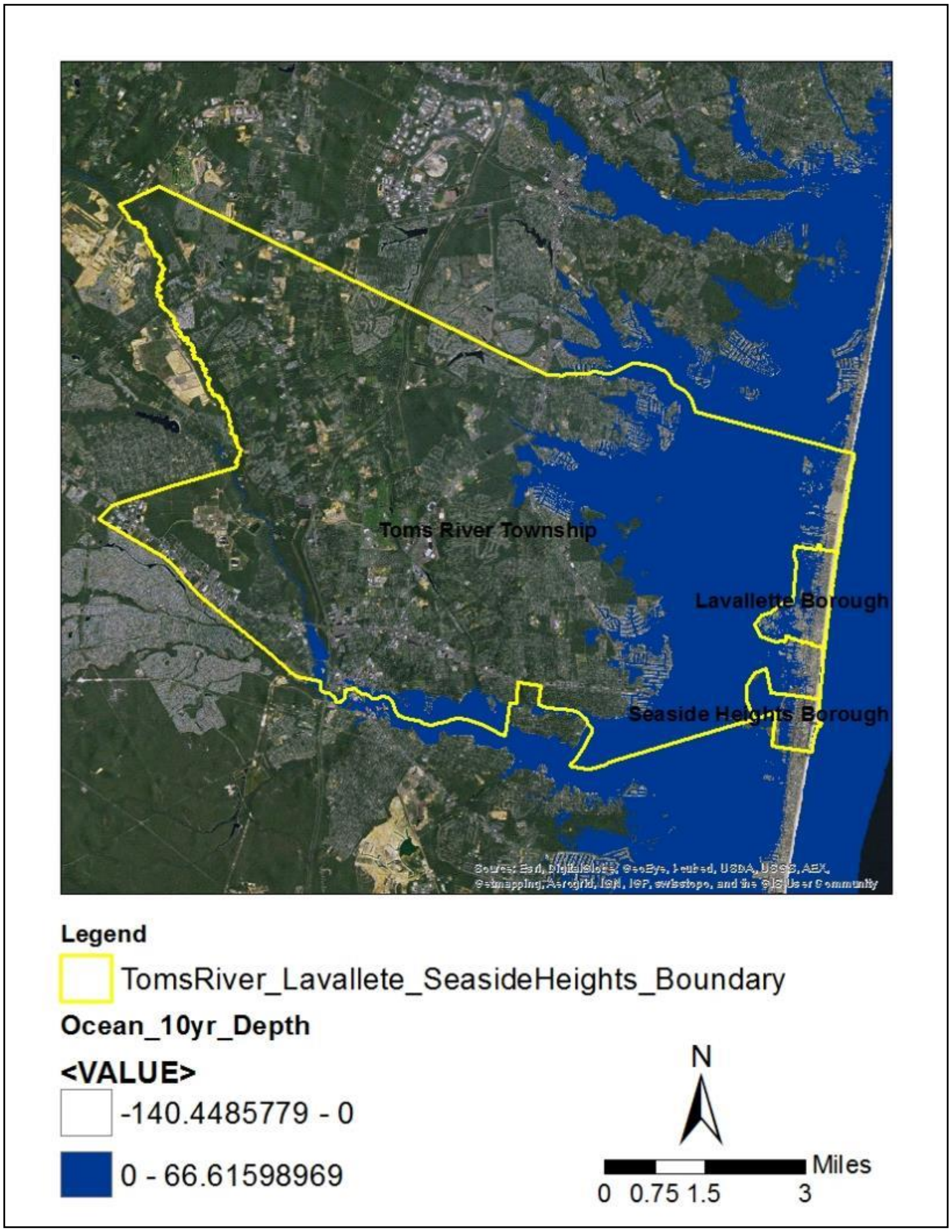


Fig. C3.1 10-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

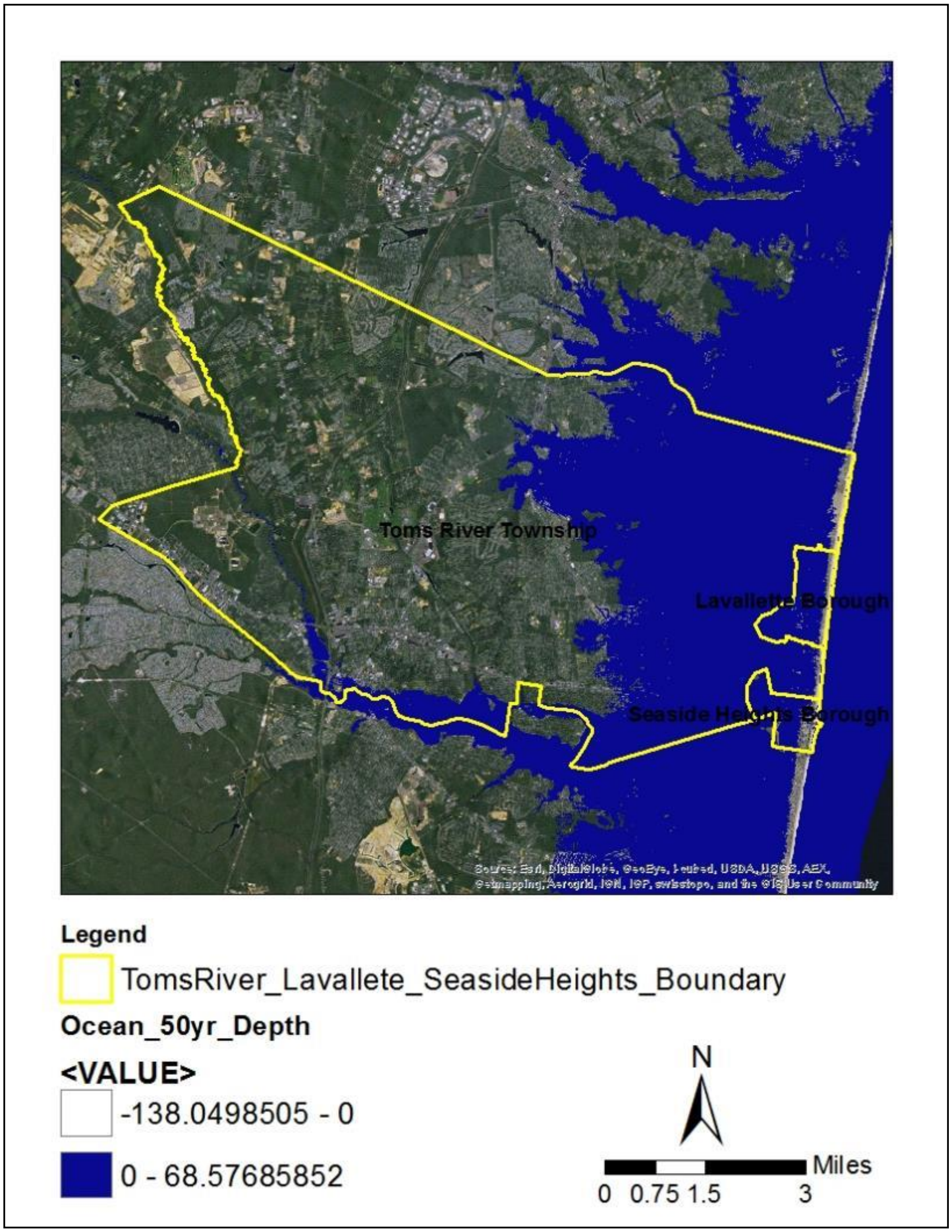


Fig. C3.2 50-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

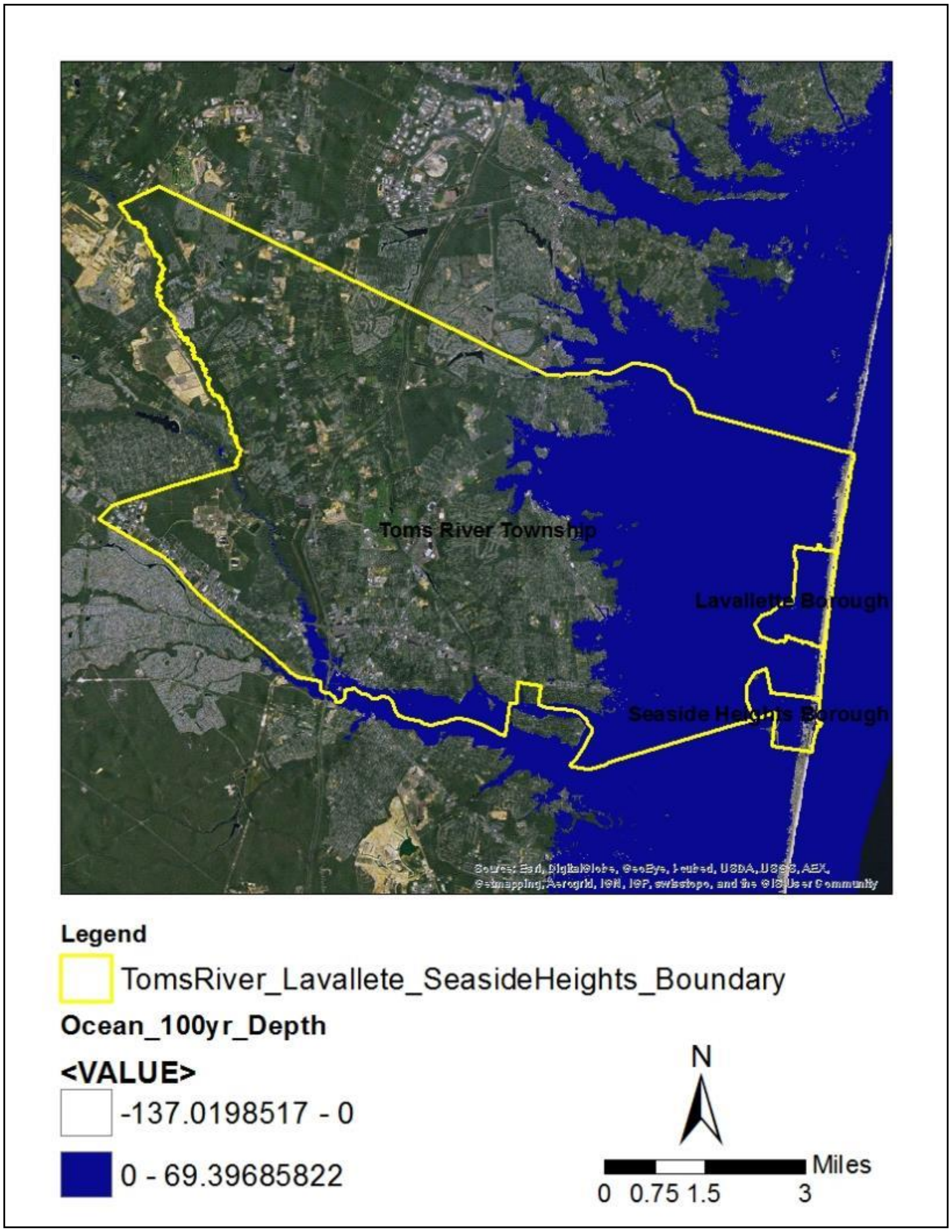


Fig. C3.3 100-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

C4 STAFFORD TOWNSHIP

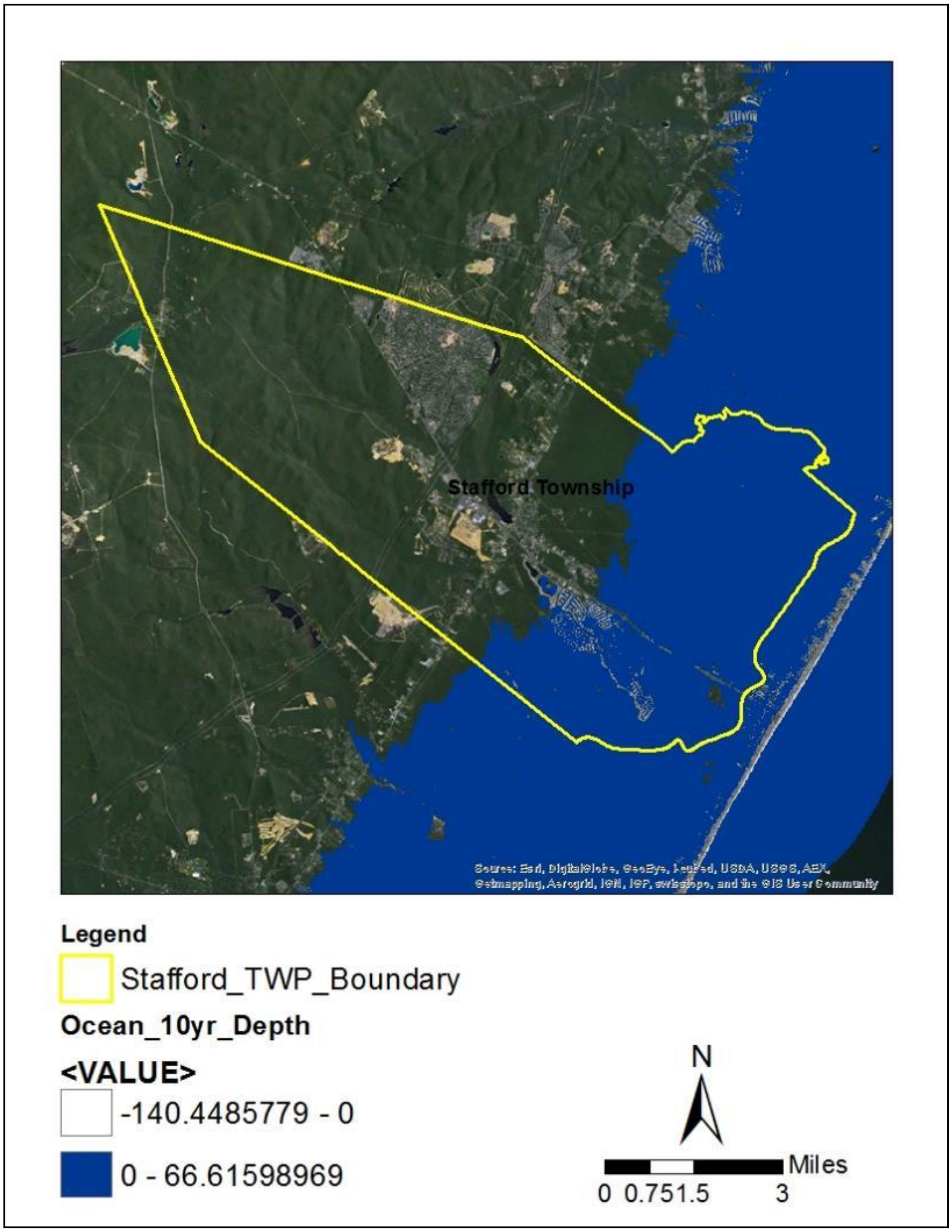


Fig. C4.1 10-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

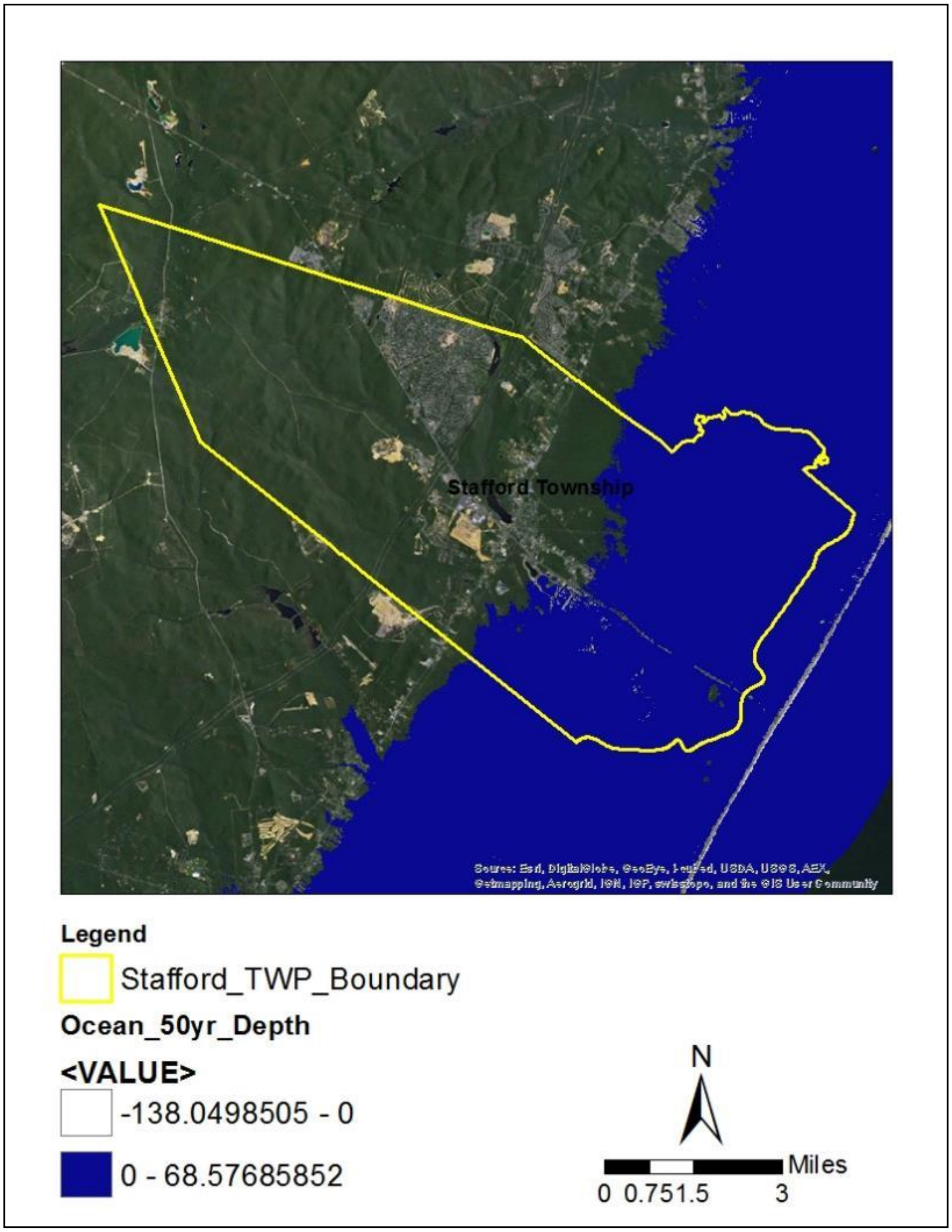


Fig. C4.2 50-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

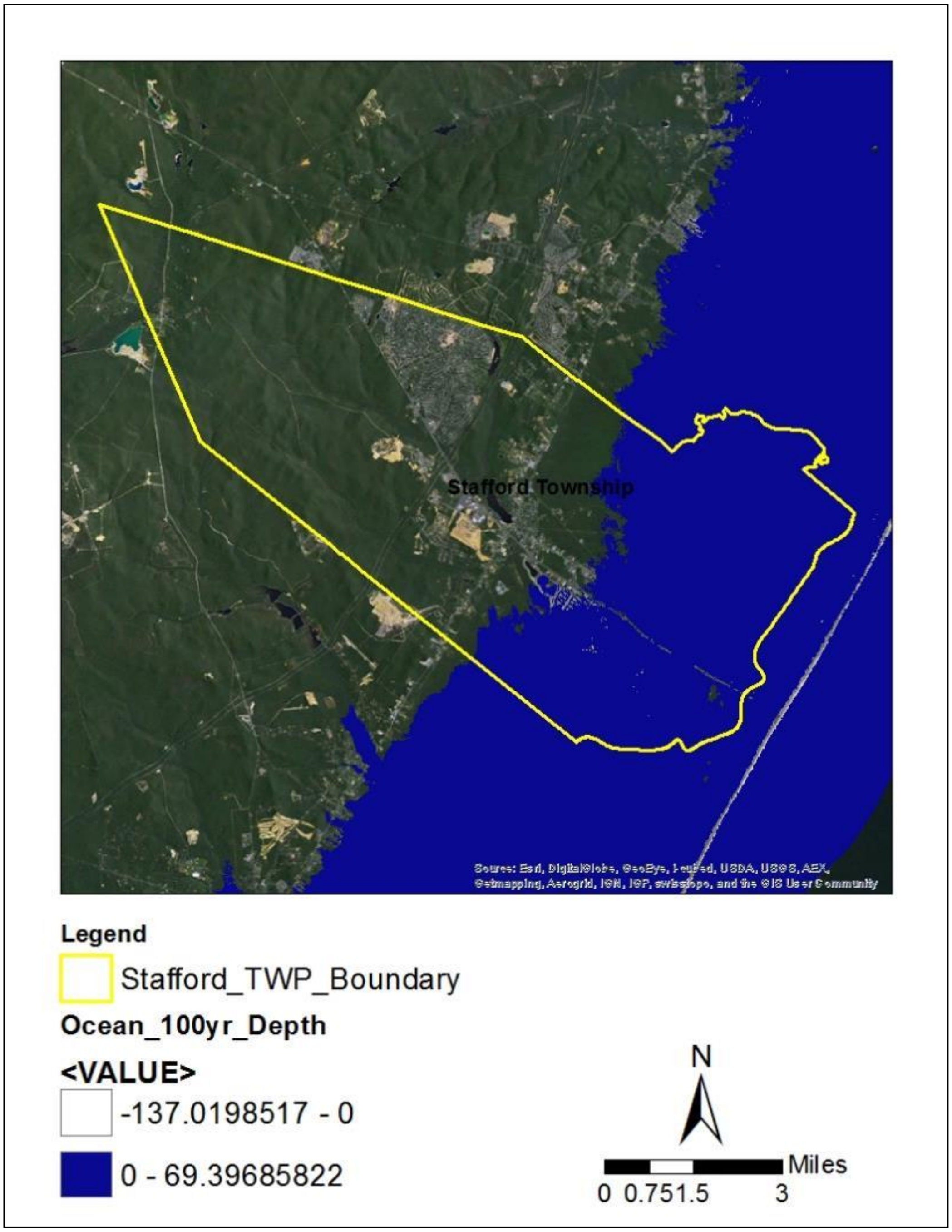


Fig. C4.3 100-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

C5 LITTLE EGG HARBOR TOWNSHIP -including Tuckerton Borough

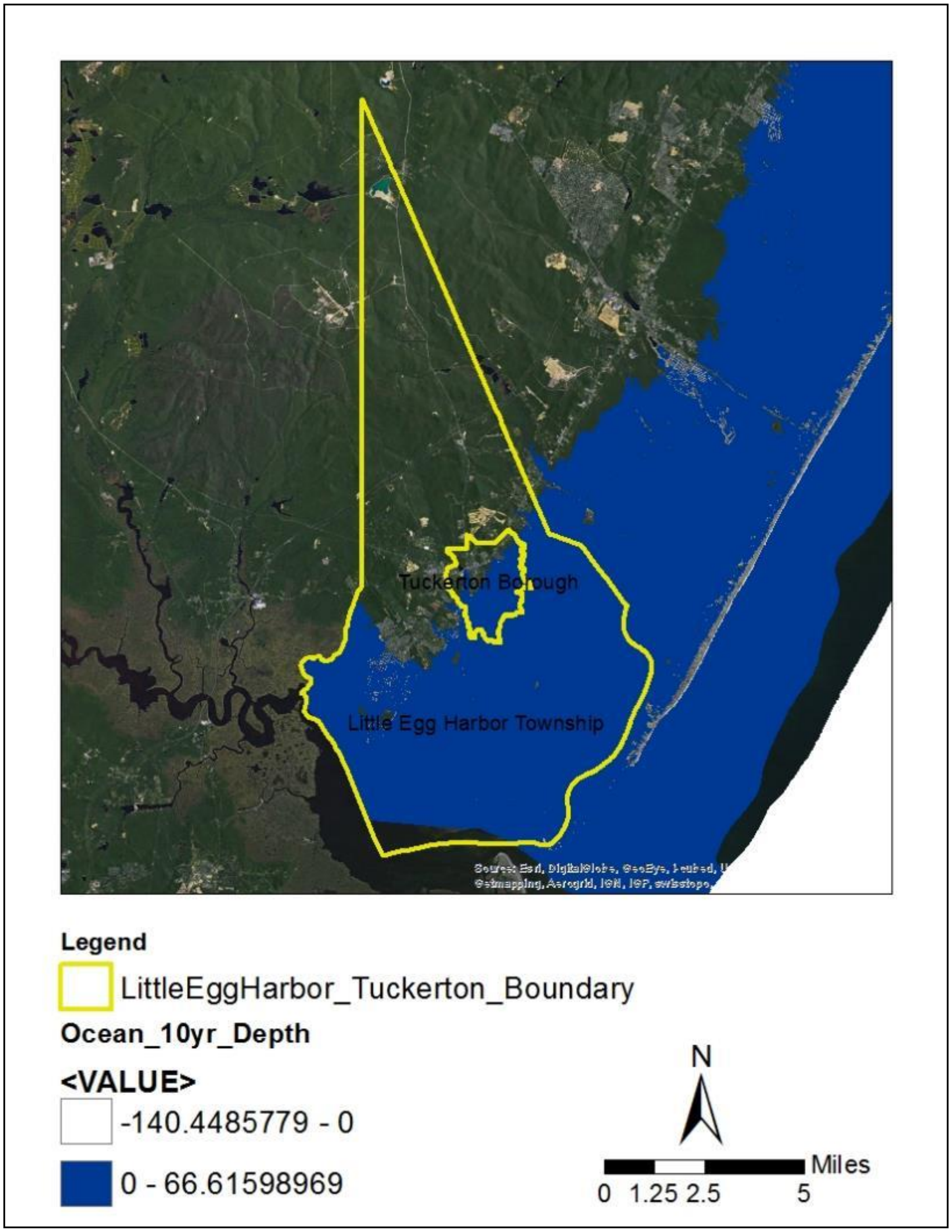


Fig. C5.1 10-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

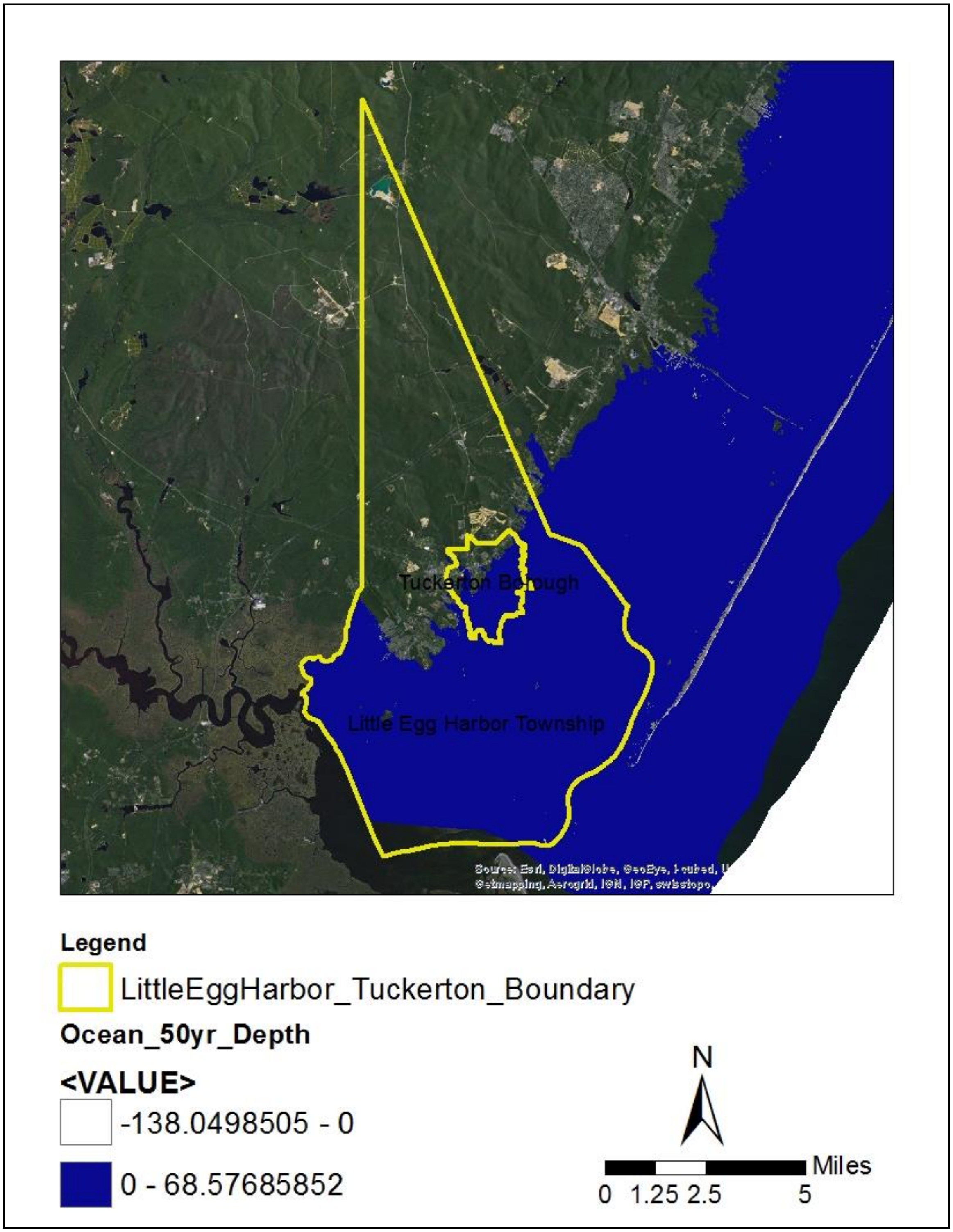


Fig. C5.2 50-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

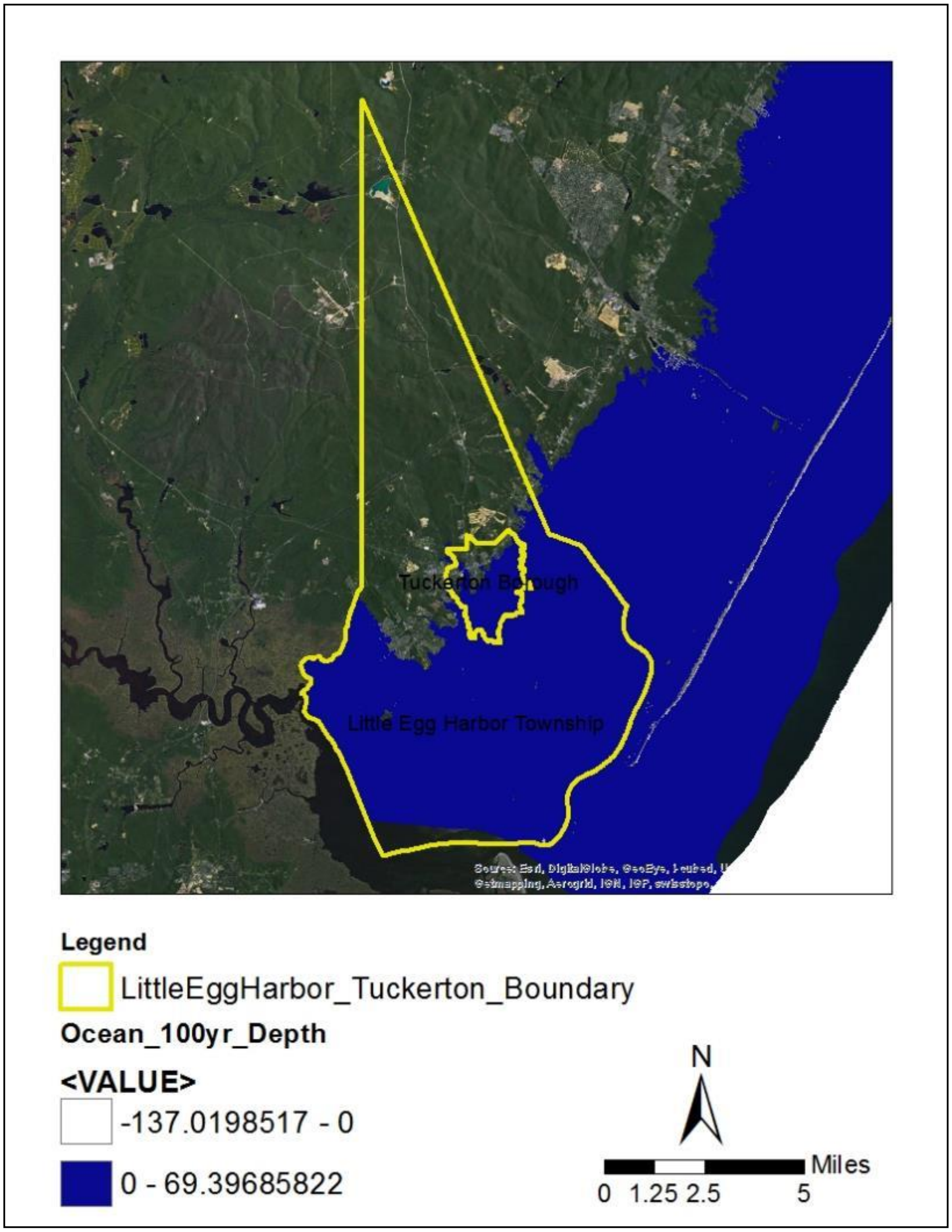


Fig. C5.3 100-Year Flood Prone Derived from FEMA Region II SWEL and DEM (Source: http://content.femadata.com/Public/PreliminaryWorkMaps/NJ/Ocean/Coastal_Data/Storm_Surge/OceanNJ_Storm_Surge.zip)

Appendix D Maps of Flood Defense Measures Placements for Each Township or Borough

D1 Point Pleasant Borough -including Point Beach Borough and Bay Head Borough

D1.1 Based on 10-Year Coastal Flood

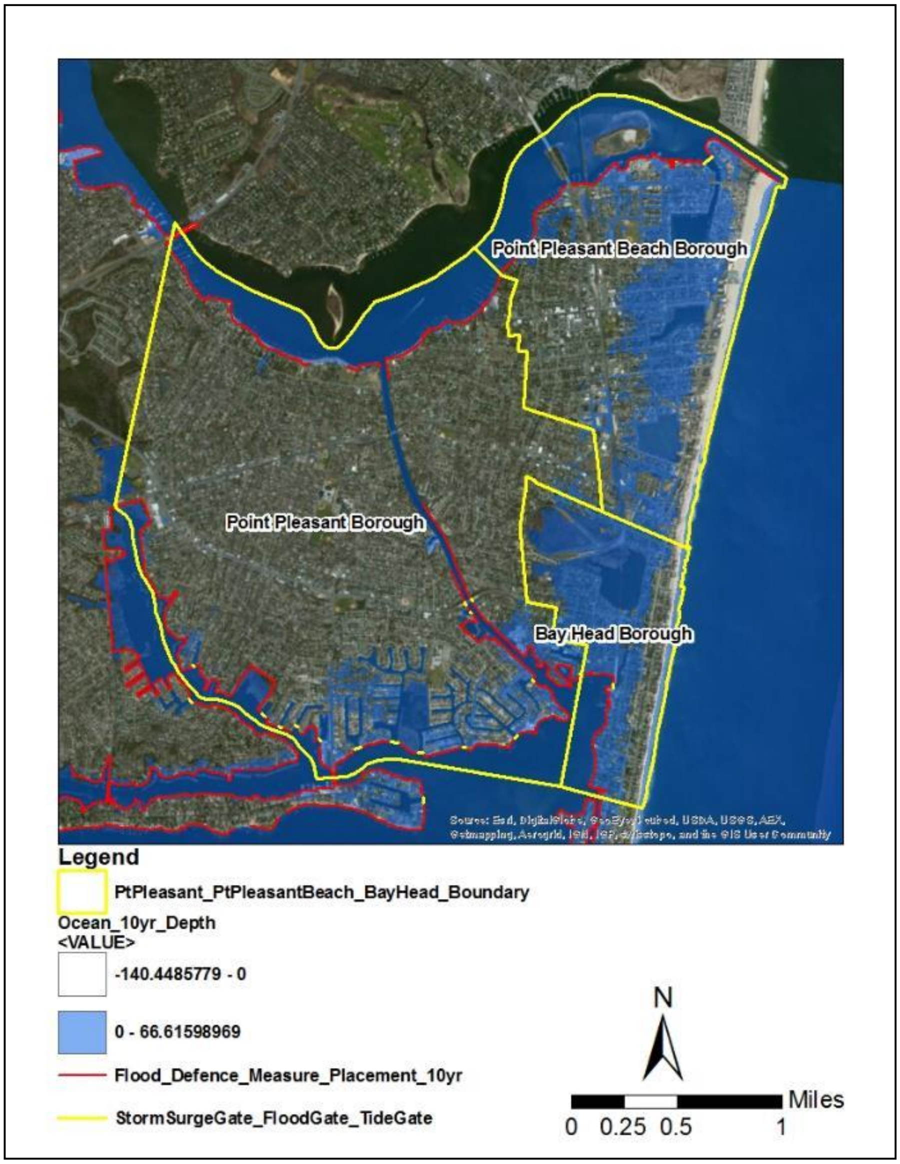


Fig. D.1.1 An Overall View of Placement of Flood Defense Measures Based on 10-Year Coastal Flood

Fig. D1.2 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 10-Year Coastal Flood Defense

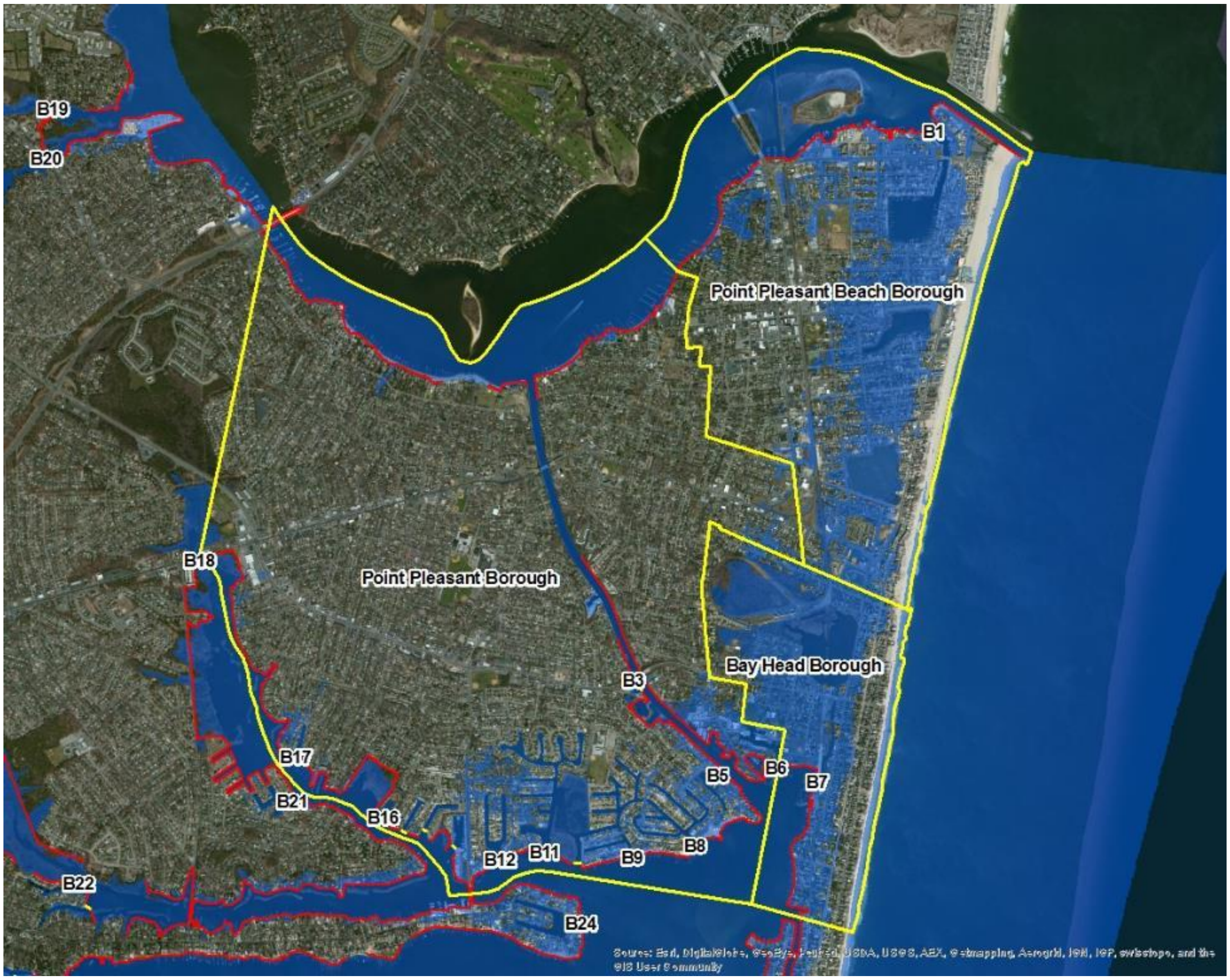


Fig. D.1.3 Identification Number (B_i) and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 10-Year Coastal Flood Defense

D1.2 Based on 50-Year Coastal Flood

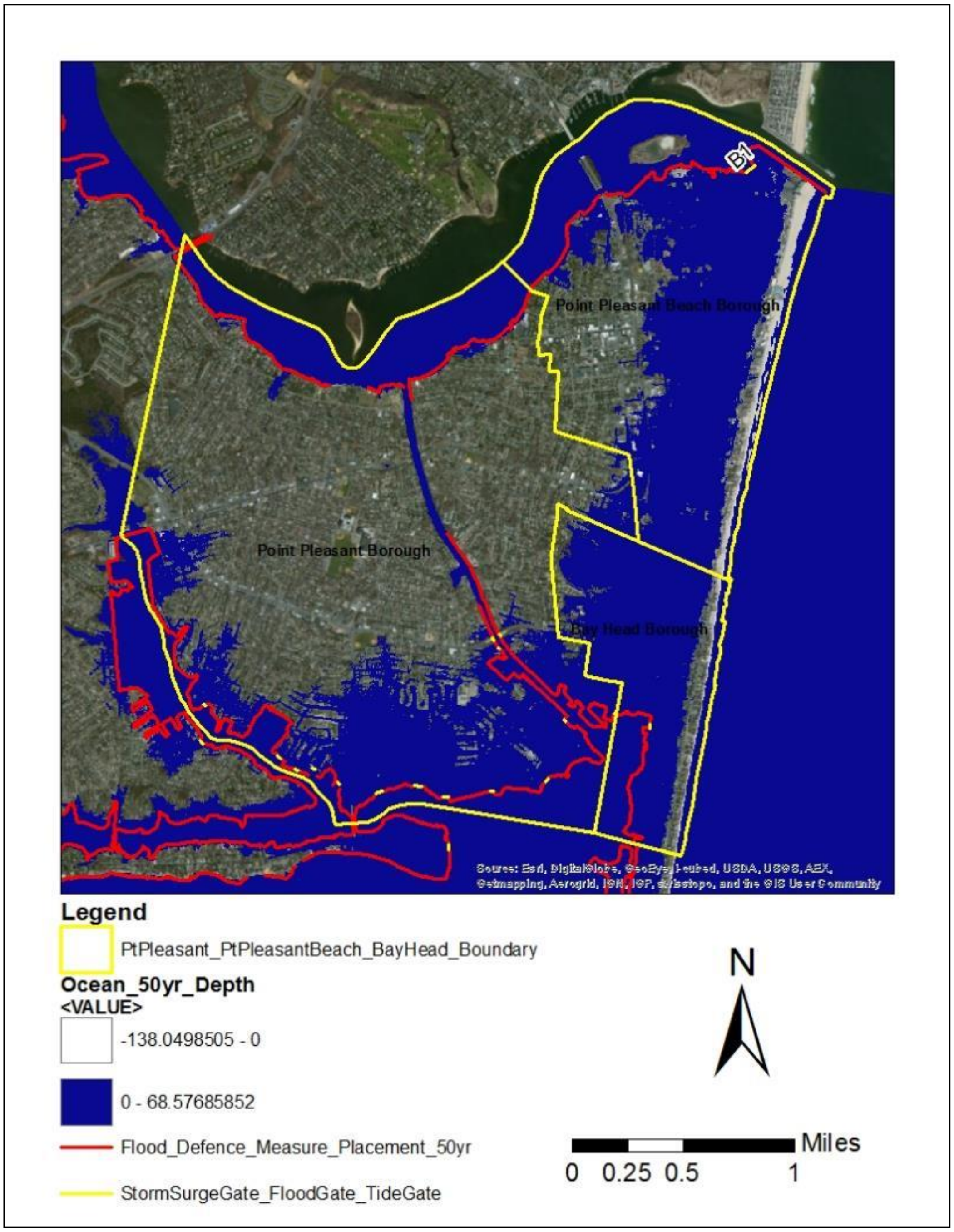


Fig. D1.4 An Overall View of Placement of Flood Defense Measures Based on 50-Year Coastal Flood

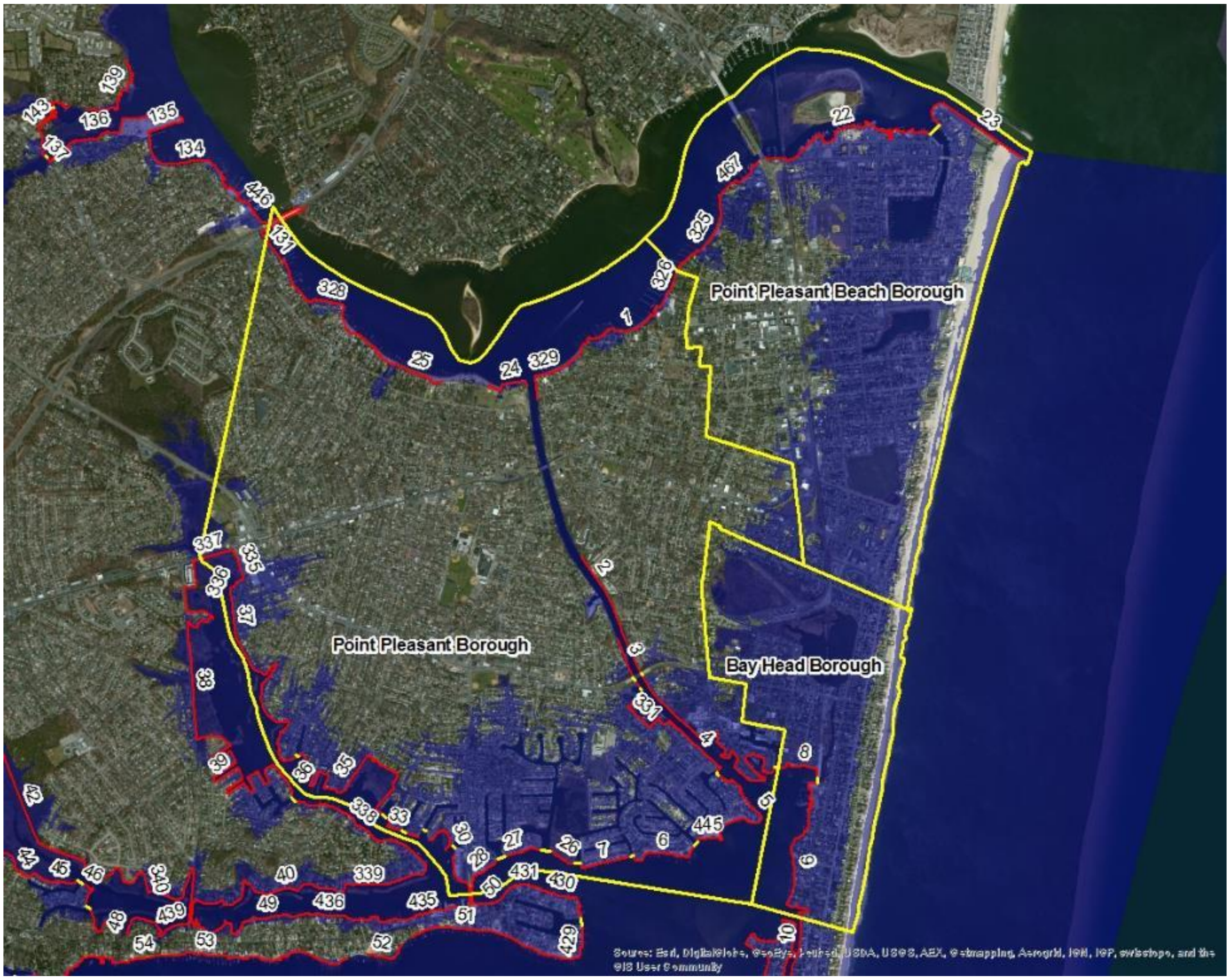


Fig. D1.5 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 50-Year Coastal Flood Defense

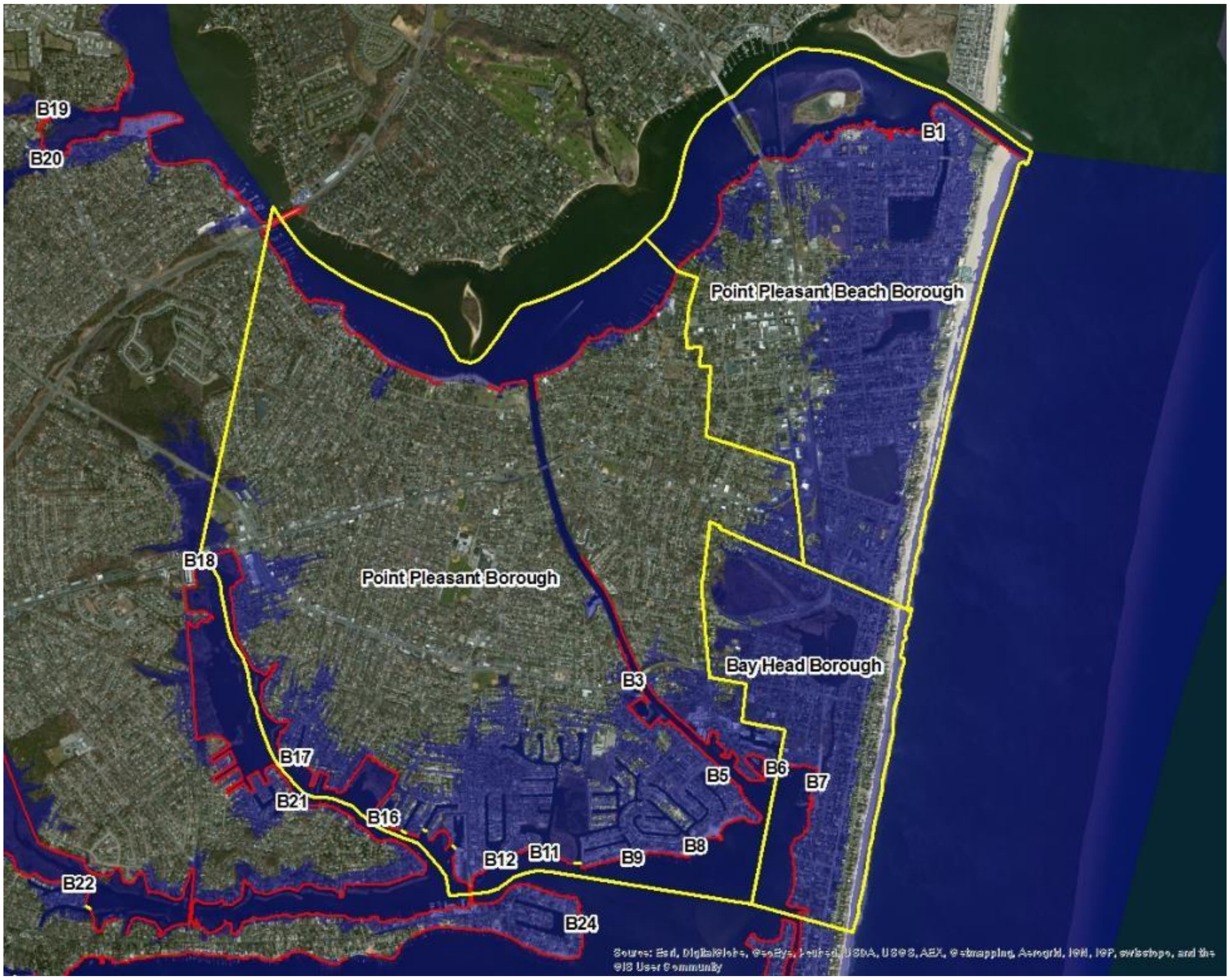


Fig. D1.6 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 50-Year Coastal Flood Defense

D1.3 Based on 100-Year Coastal Flood

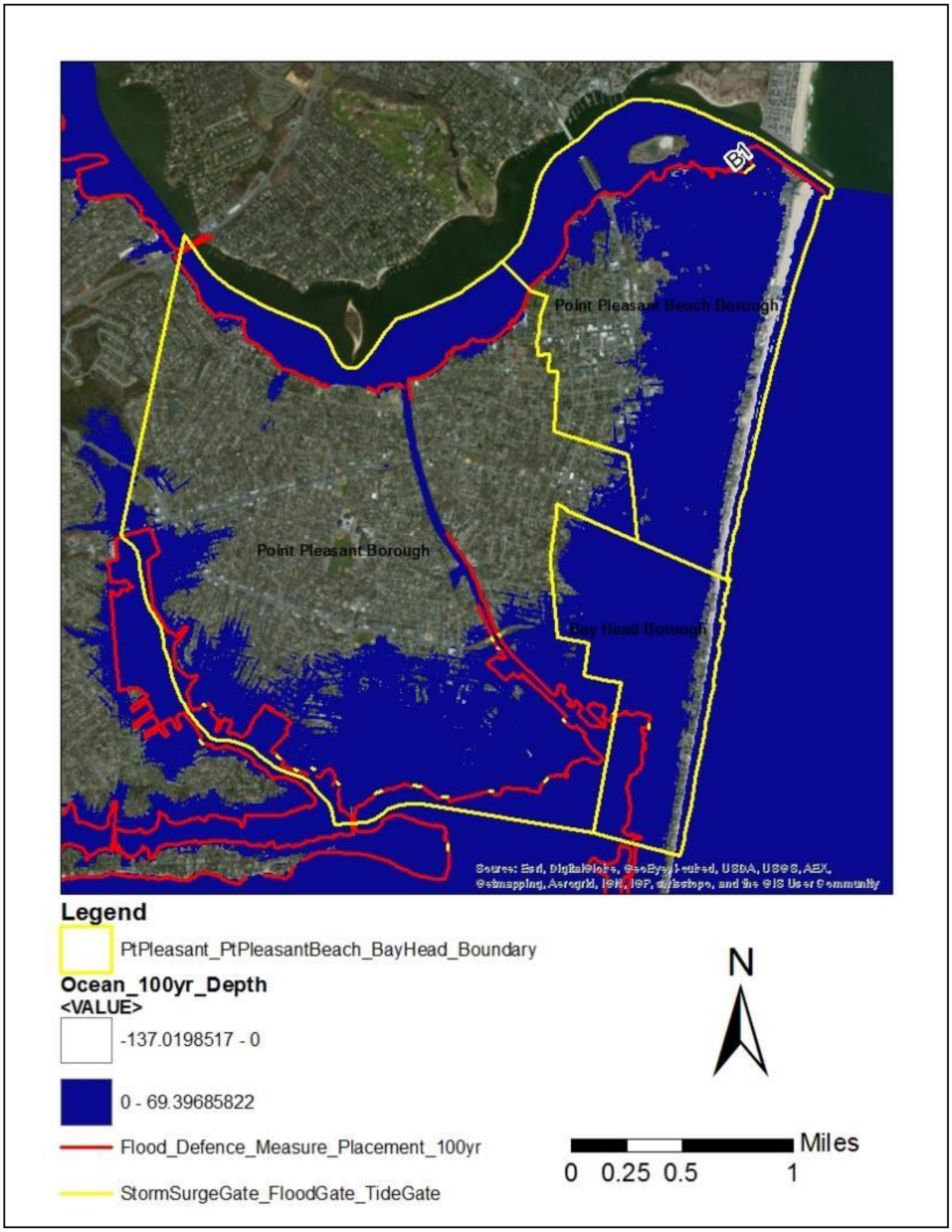


Fig. D1.7 An Overall View of Placement of Flood Defense Measures Based on 100-Year Coastal Flood

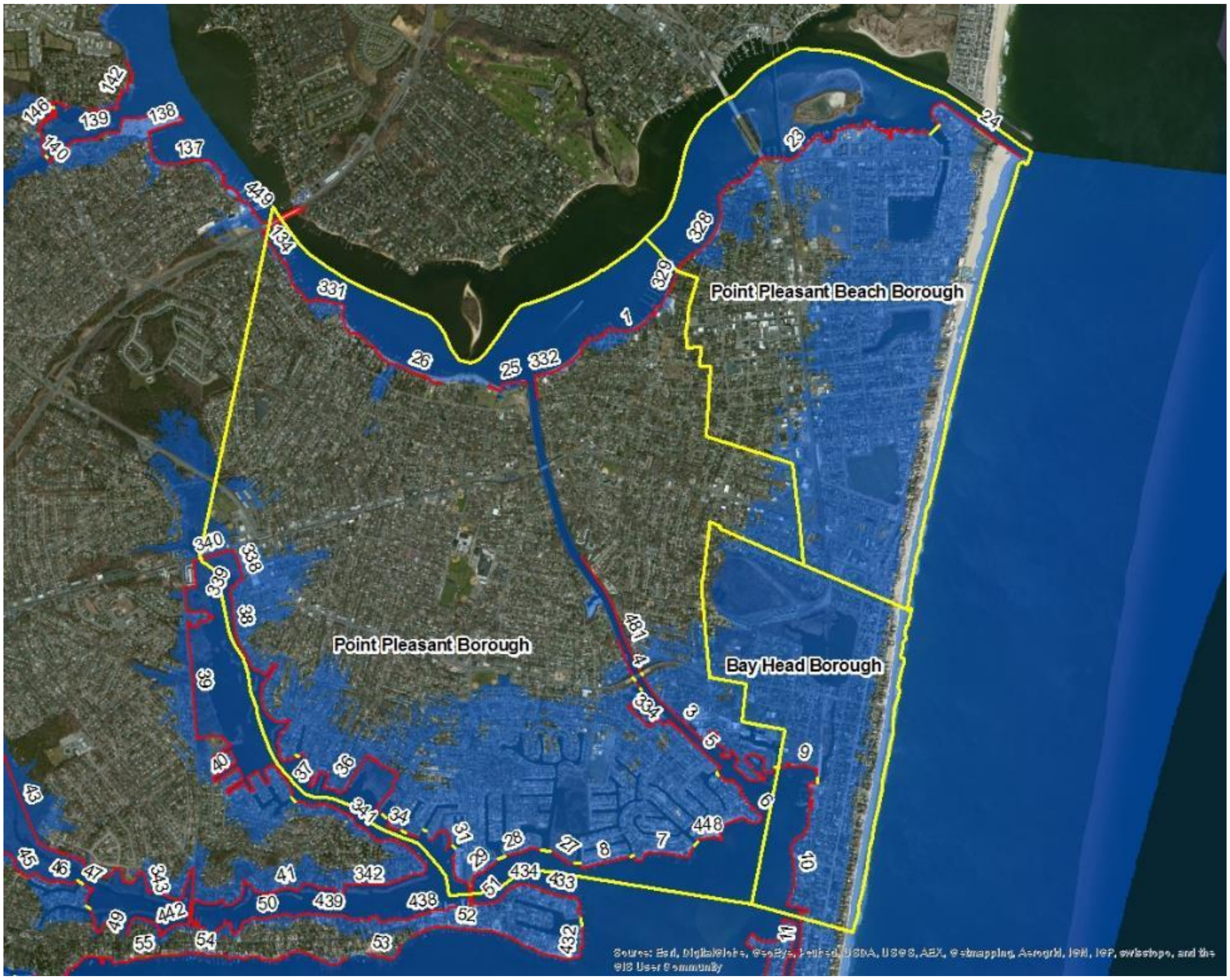


Fig. D1.8 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 100-Year Coastal Flood Defense

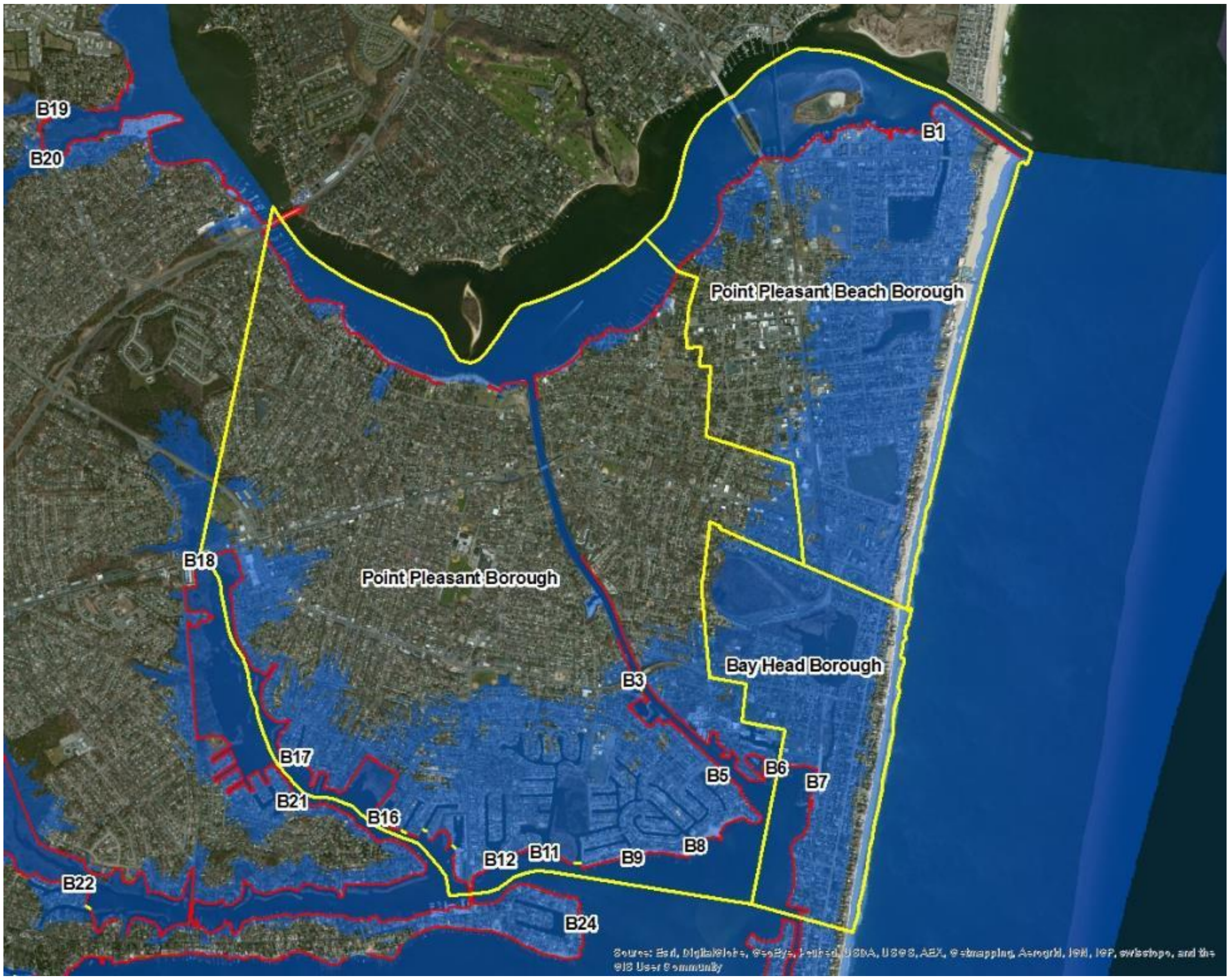


Fig. D1.9 Identification Number (B_i) and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 100-Year Coastal Flood Defense

D2 Brick Township -including Mantoloking Borough

D2.1 Based on 10-Year Coastal Flood

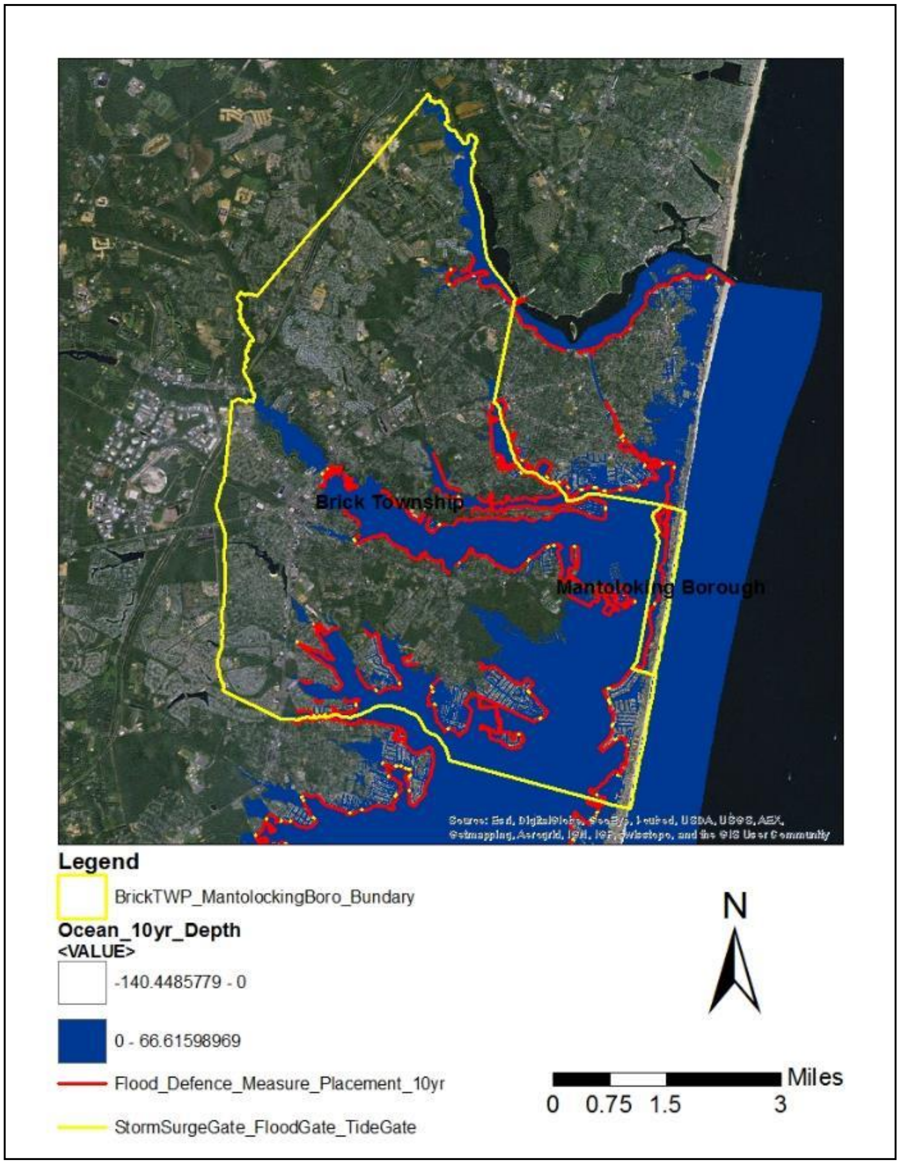


Fig. D2.1 An Overall View of Placement of Flood Defense Measures Based on 10-Year Coastal Flood

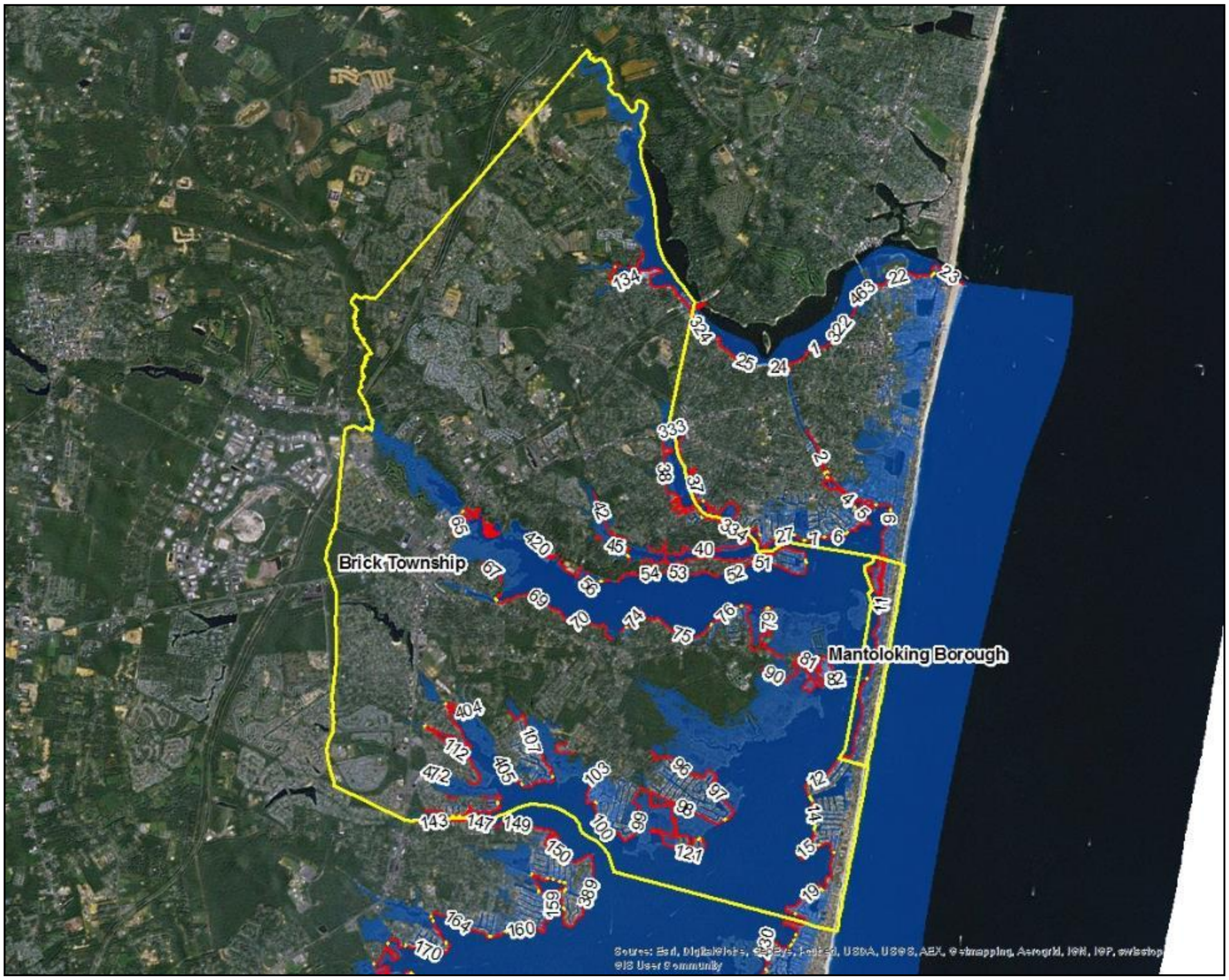


Fig. D2.2 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 10-Year Coastal Flood Defense

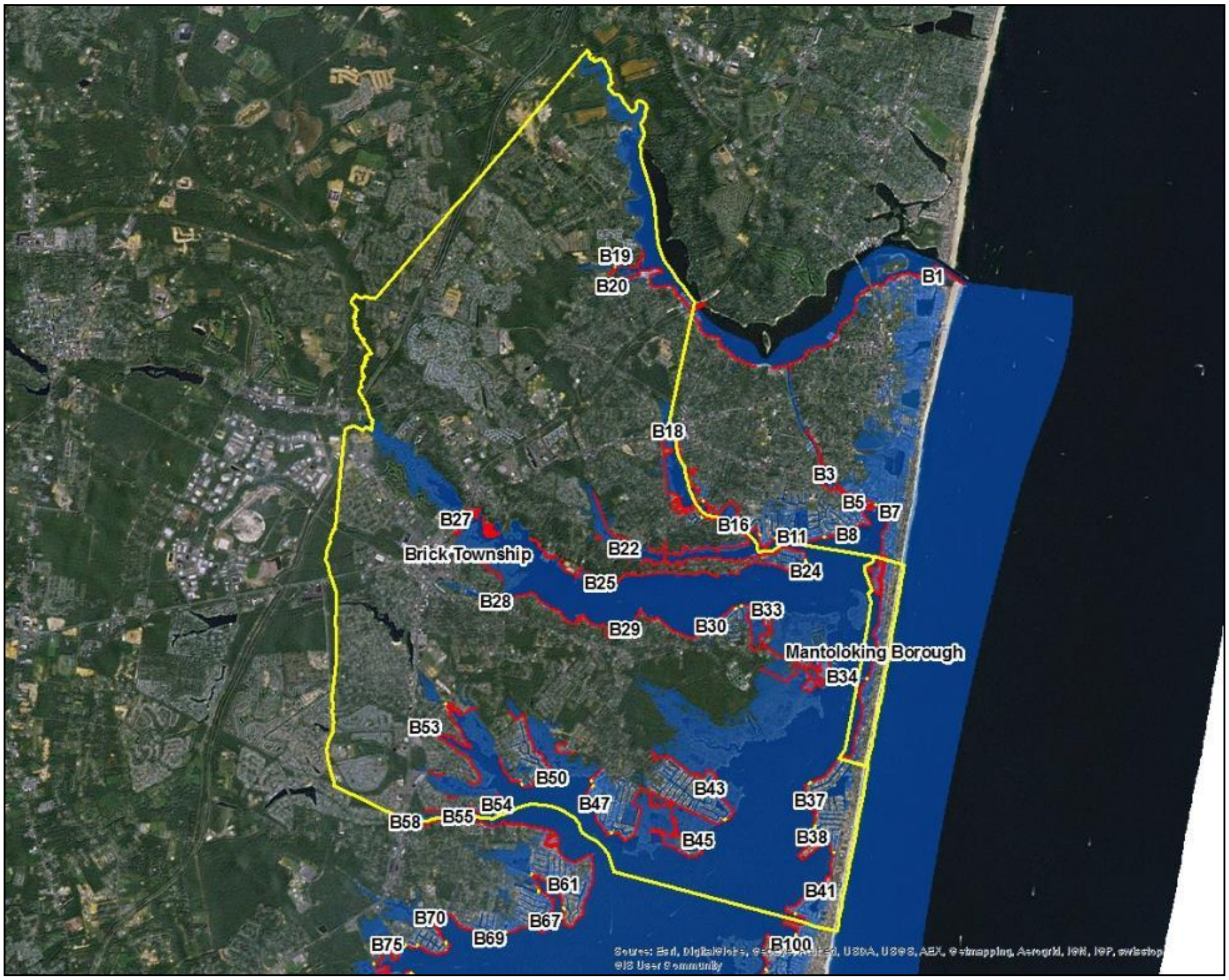


Fig. D2.3 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 10-Year Coastal Flood Defense

D2.2 Based on 50-Year Coastal Flood

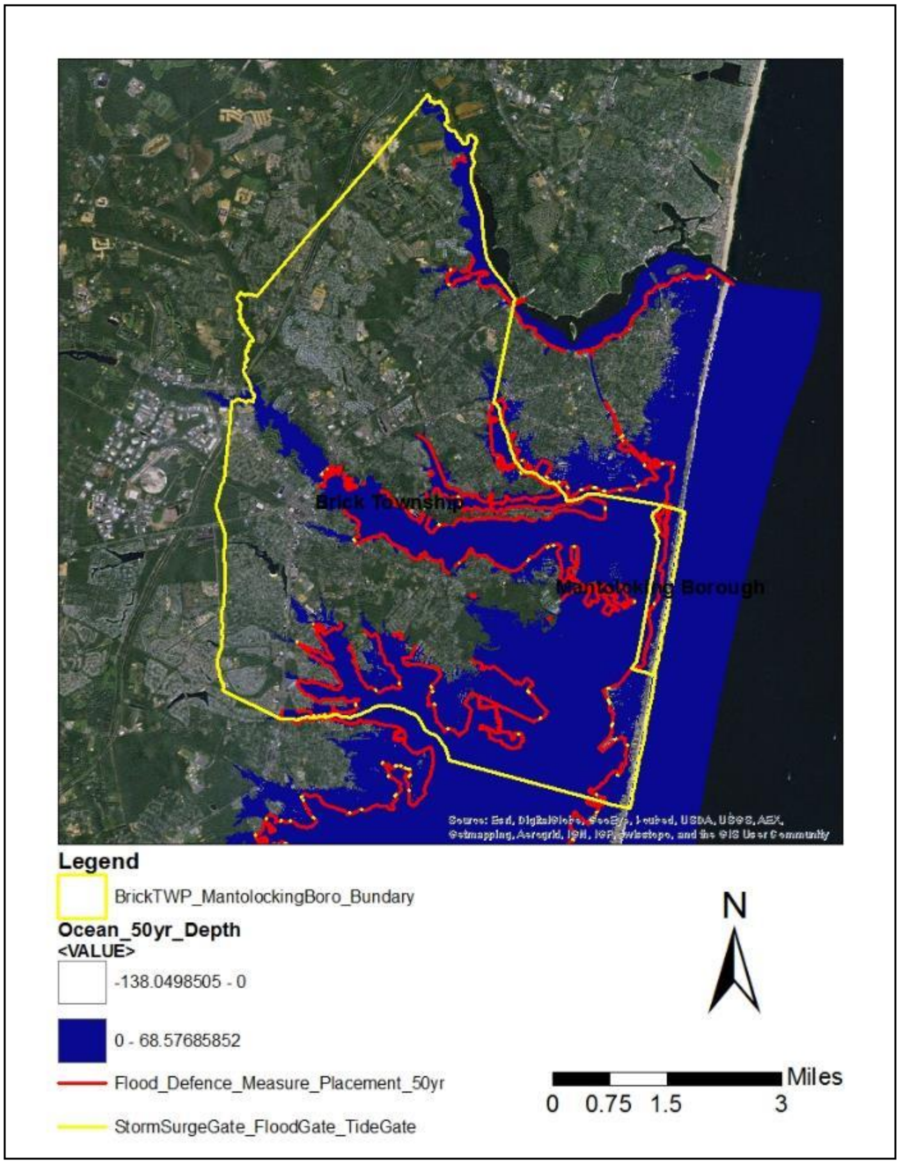


Fig. D2.4 An Overall View of Placement of Flood Defense Measures Based on 50-Year Coastal Flood

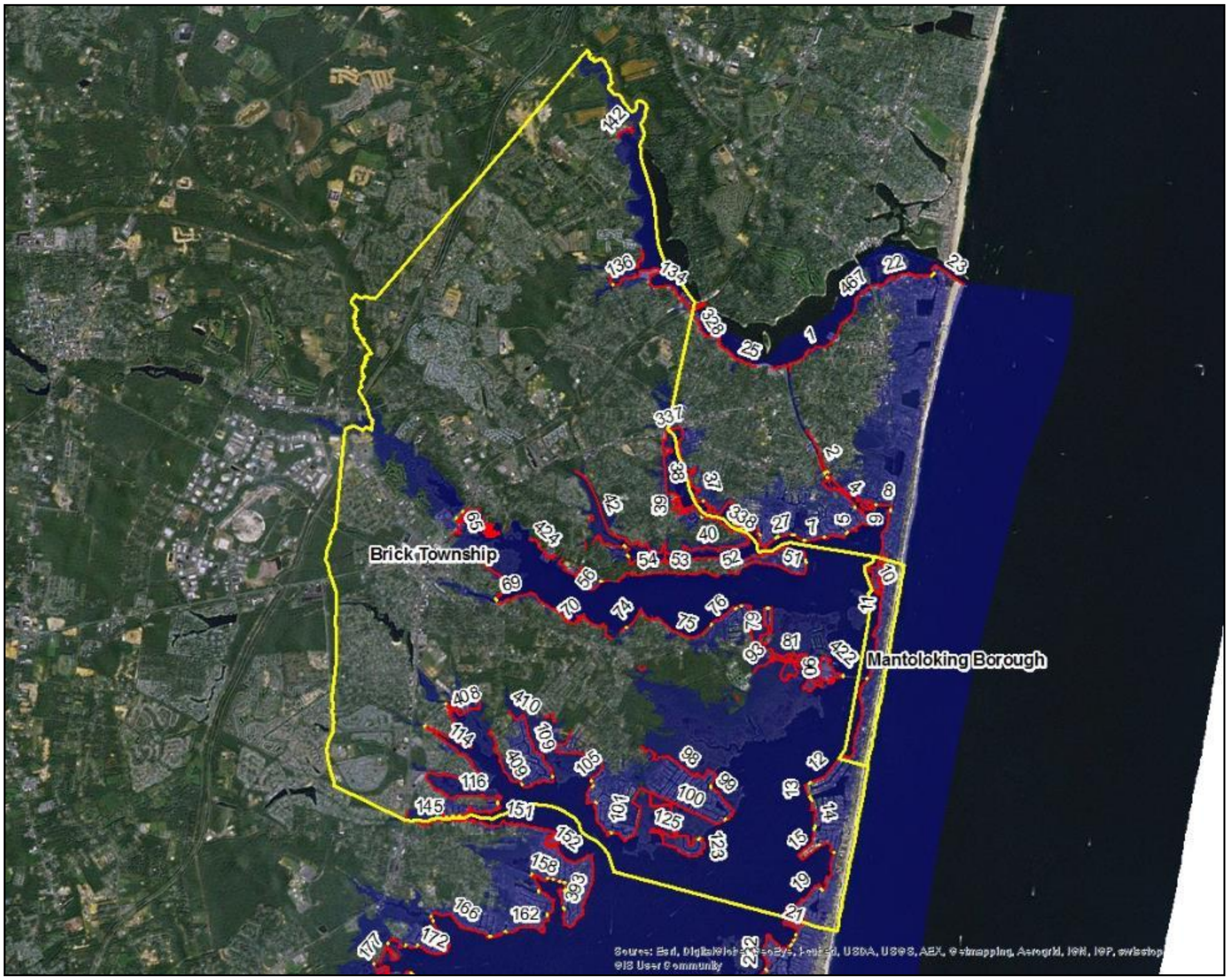


Fig. D2.5 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 50-Year Coastal Flood Defense

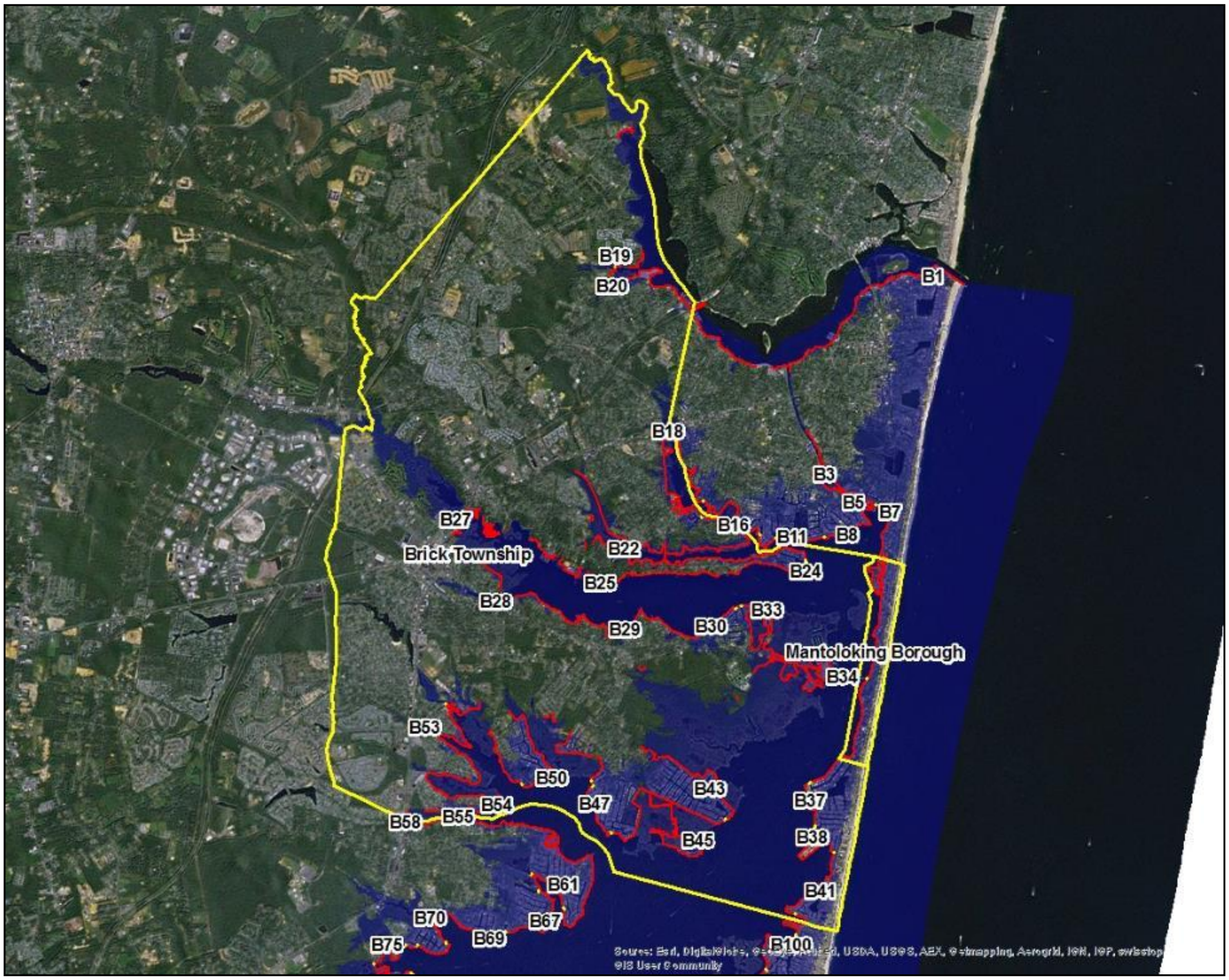


Fig. D2.6 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 50-Year Coastal Flood Defense

D2.3 Based on 100-Year Coastal Flood

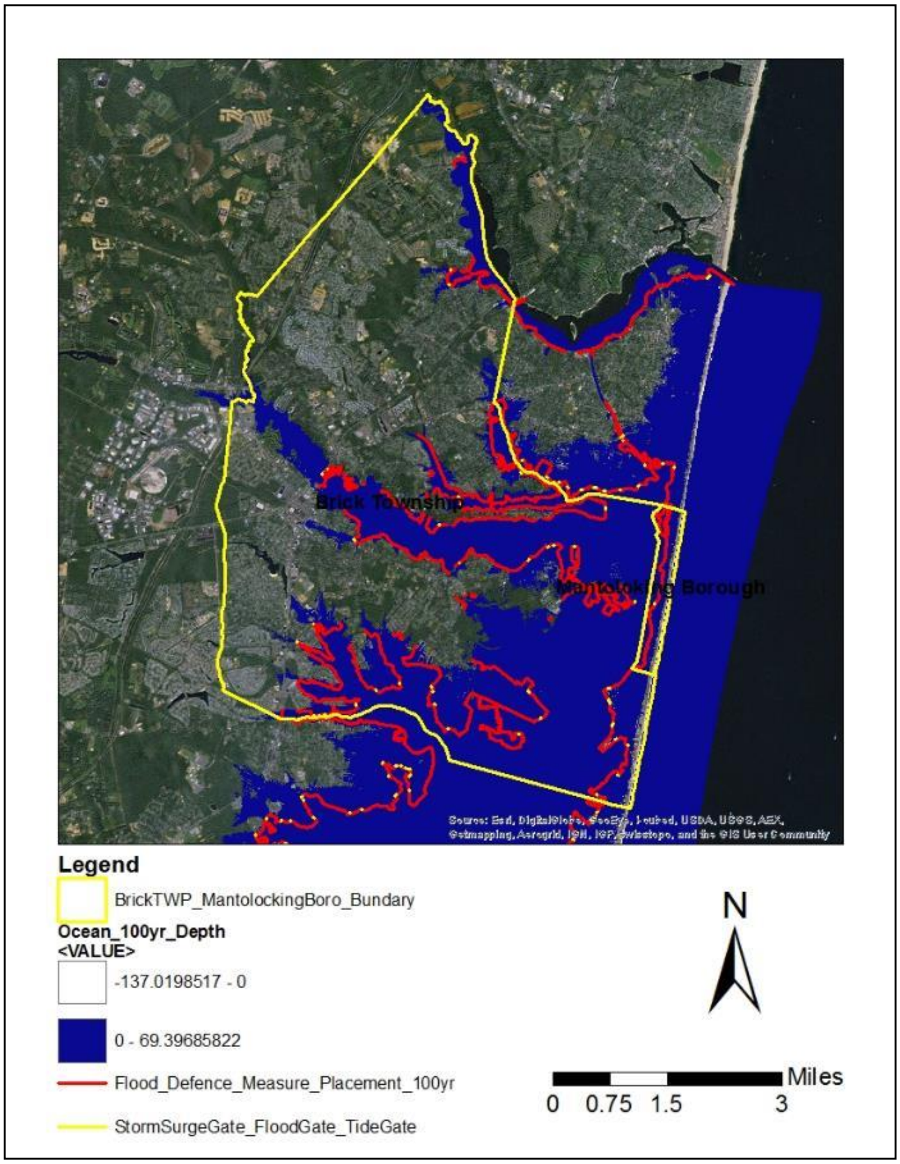


Fig. D2.7 An Overall View of Placement of Flood Defense Measures Based on 100-Year Coastal Flood

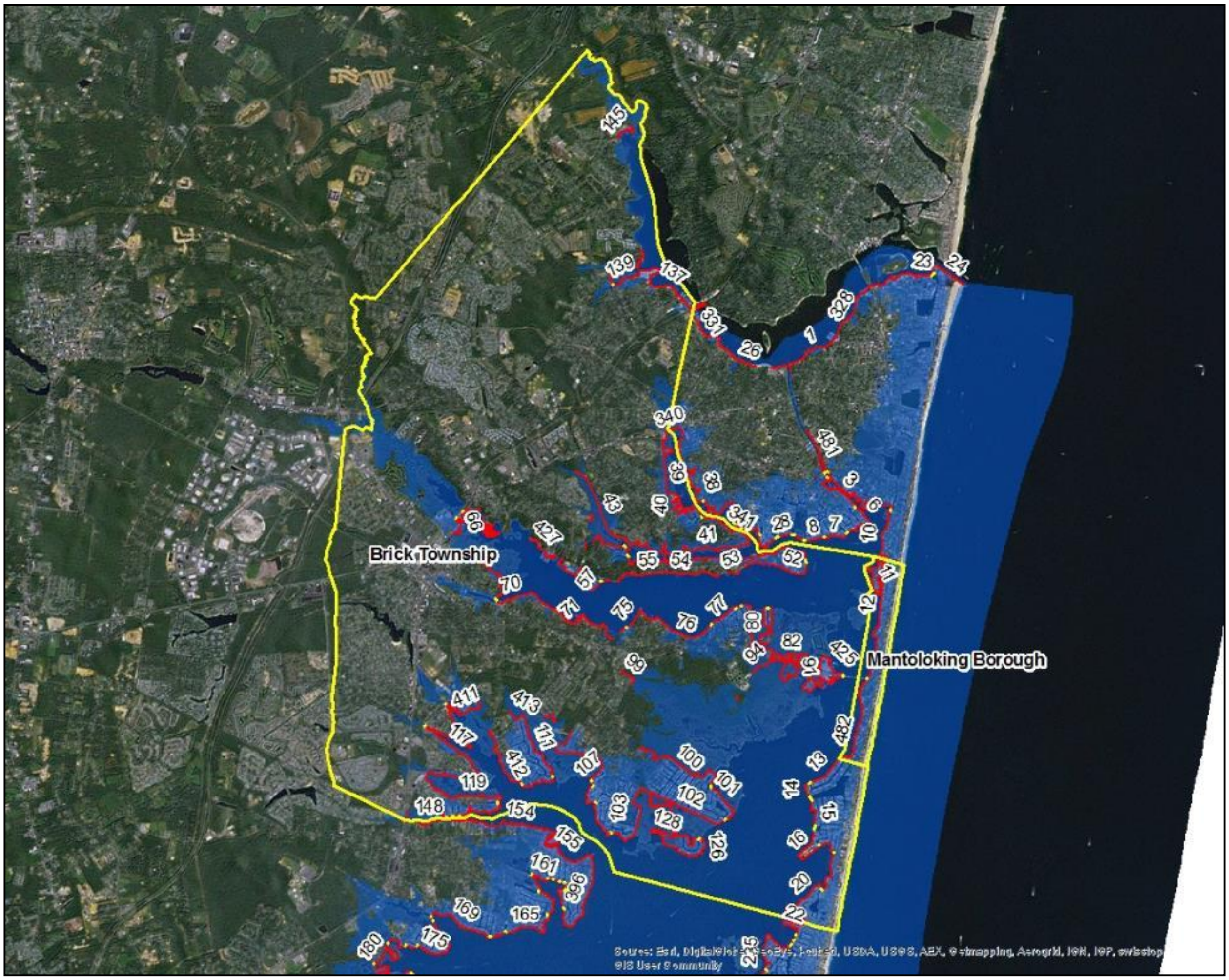


Fig. D2.8 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 100-Year Coastal Flood Defense

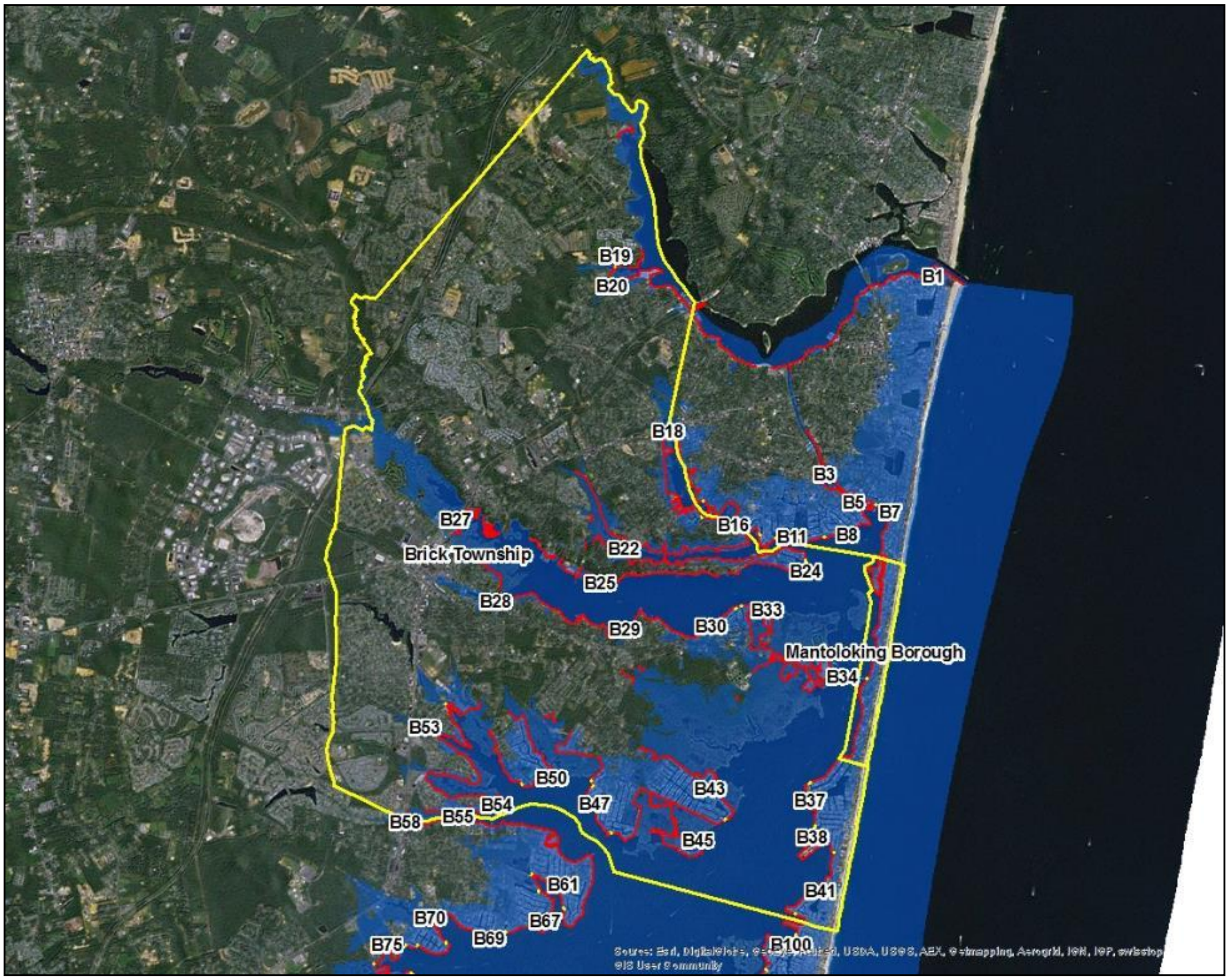


Fig. D2.9 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 100-Year Coastal Flood Defense

D3 Toms River TWP -including Lavallette Borough and Seaside Heights Borough

D3.1 Based on 10-Year Coastal Flood

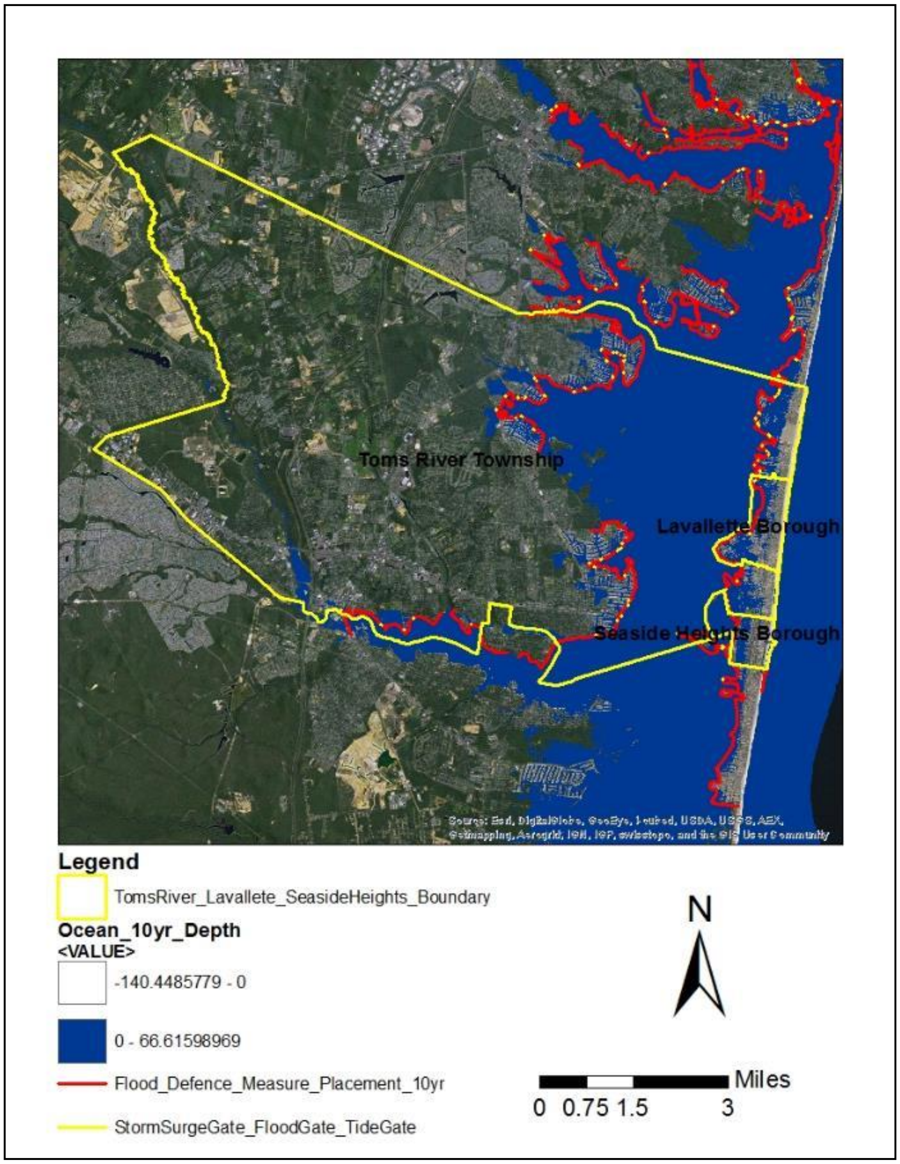


Fig. D3.1 An Overall View of Placement of Flood Defense Measures Based on 10-Year Coastal Flood

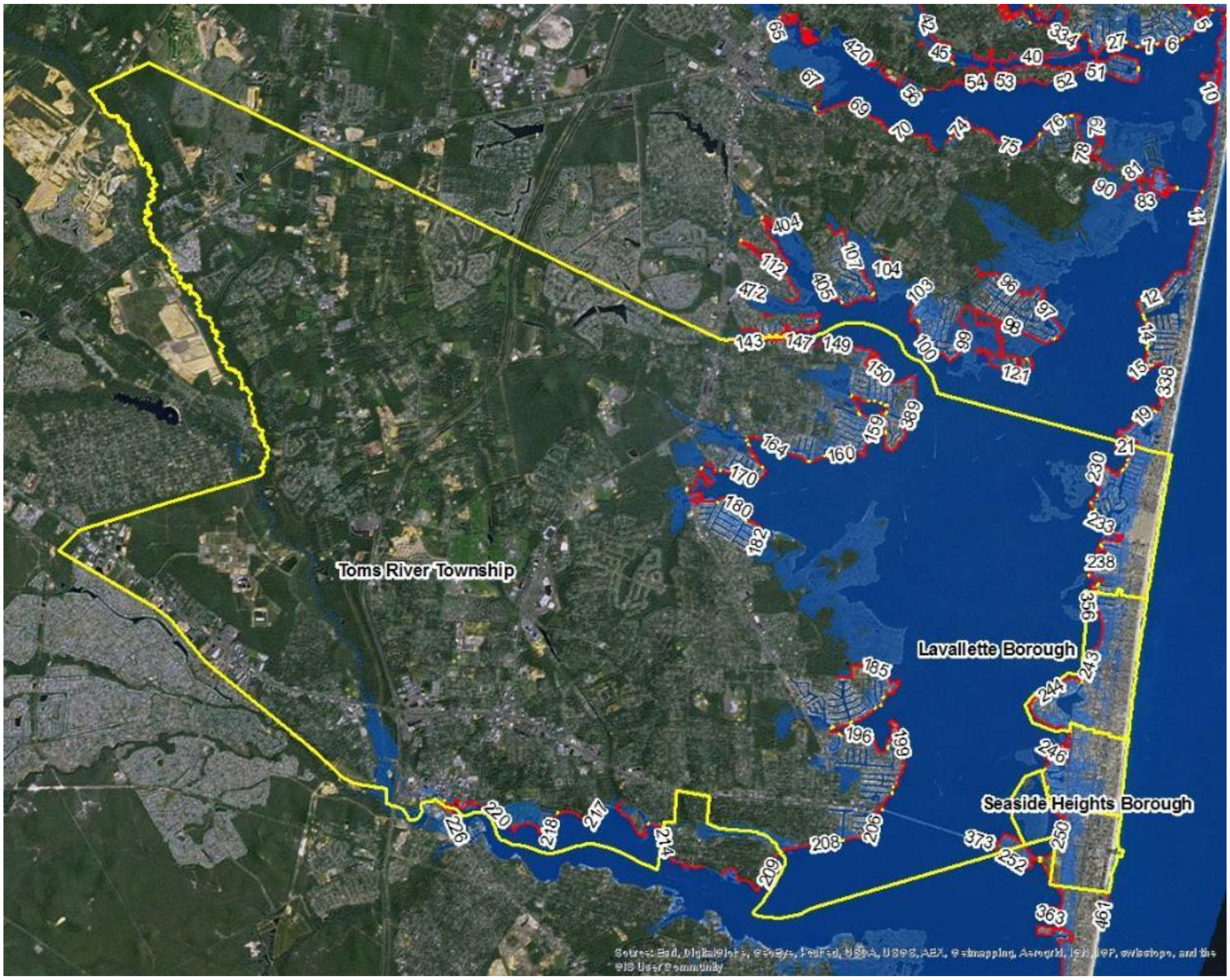


Fig. D3.2 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 10-Year Coastal Flood Defense

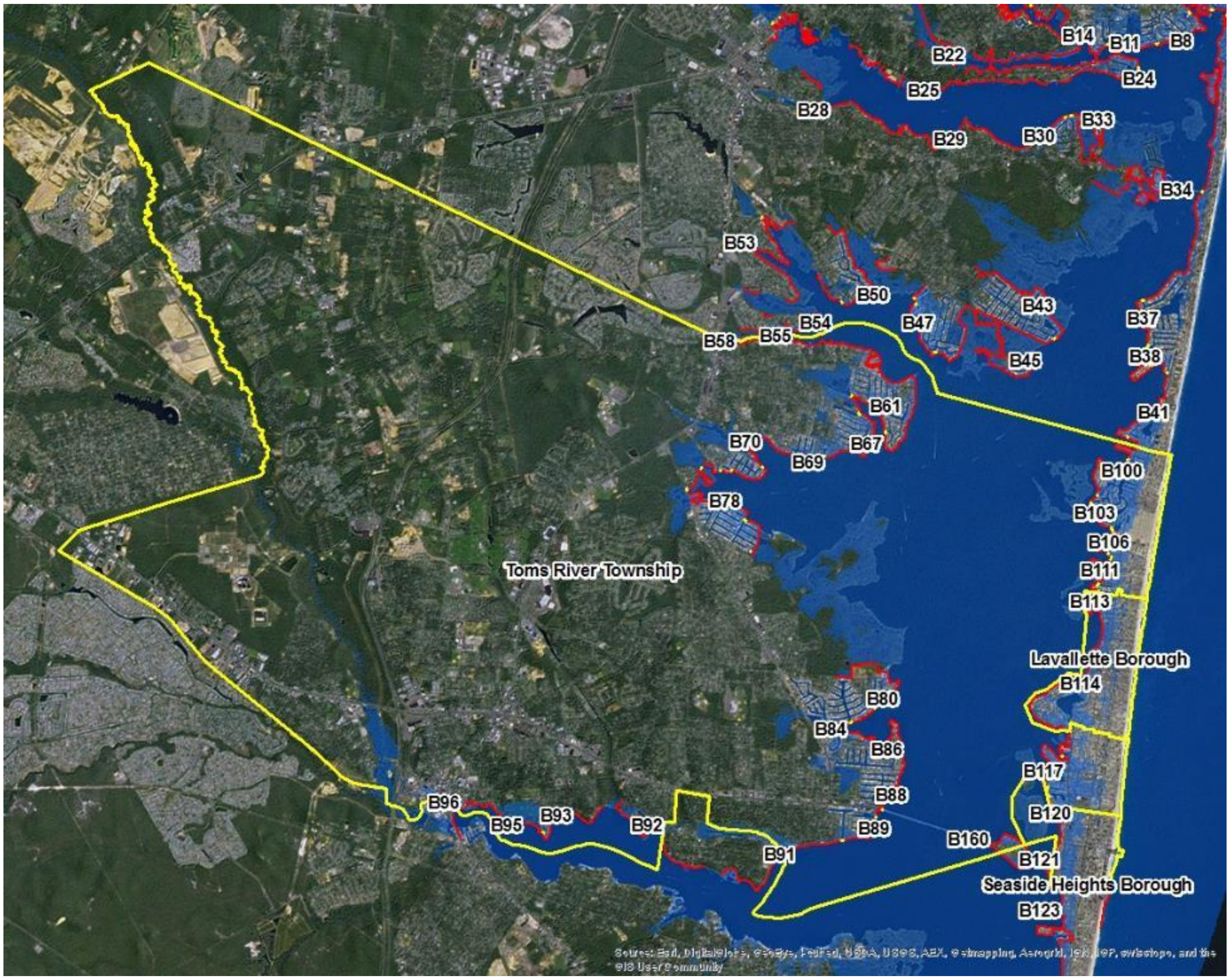


Fig. D3.3 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 10-Year Coastal Flood Defense

D3.2 Based on 50-Year Coastal Flood

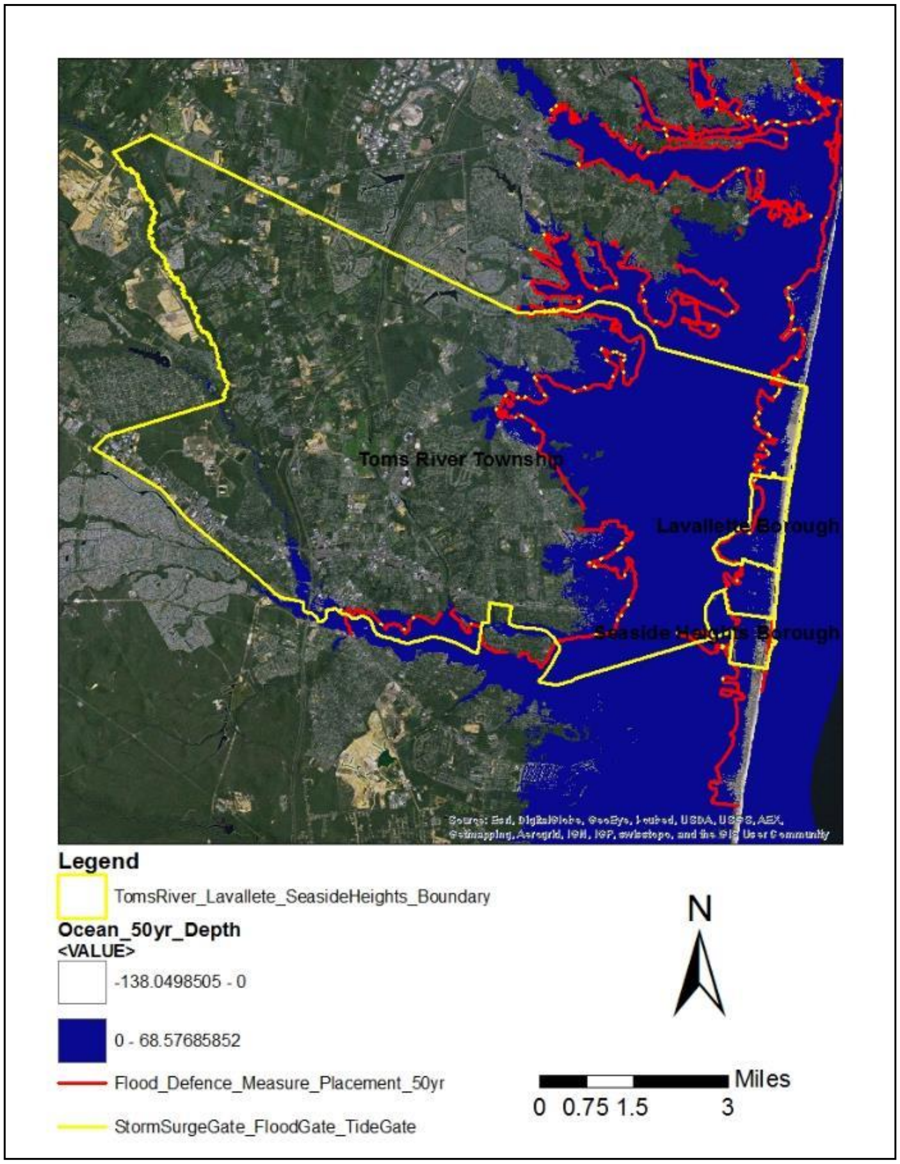


Fig. D3.4 An Overall View of Placement of Flood Defense Measures Based on 50-Year Coastal Flood

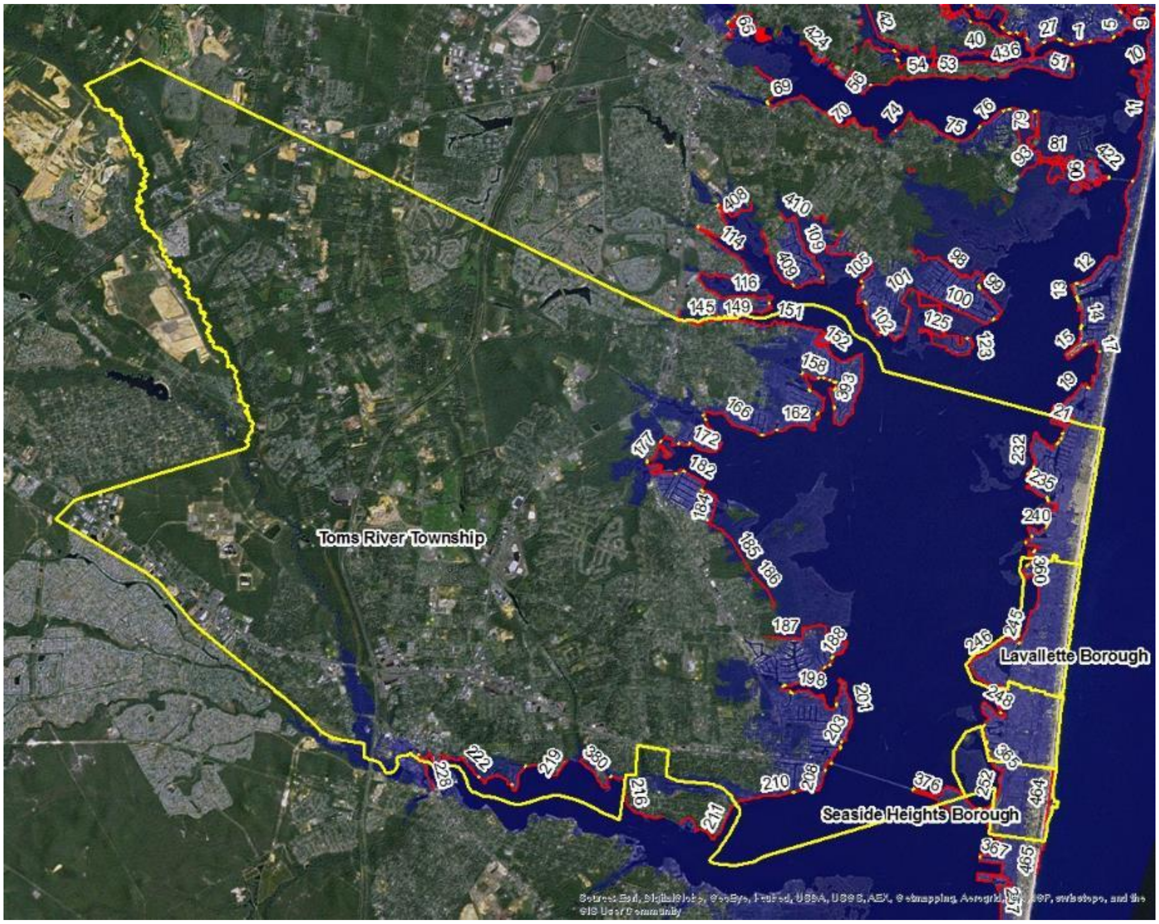


Fig. D3.5 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 50-Year Coastal Flood Defense

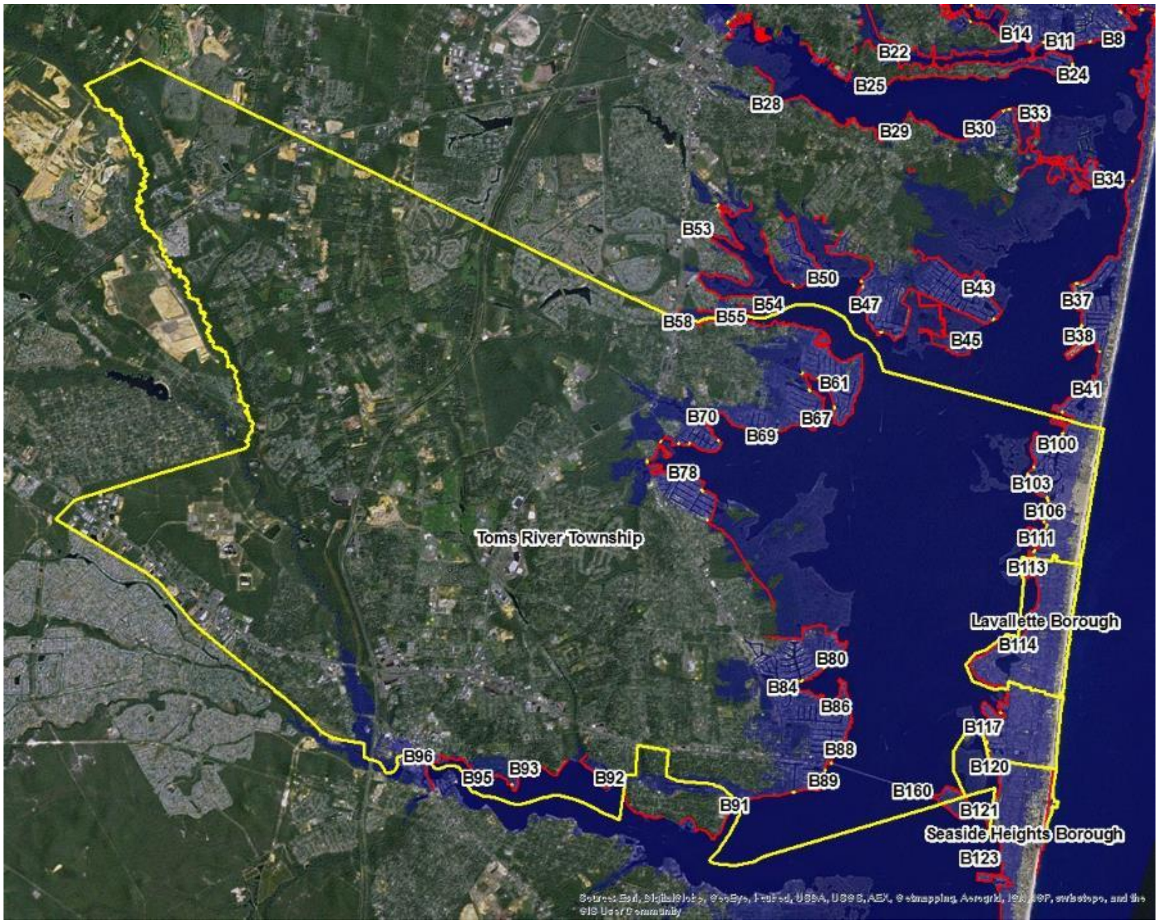


Fig. D3.6 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 50-Year Coastal Flood Defense

D3.3 Based on 100-Year Coastal Flood

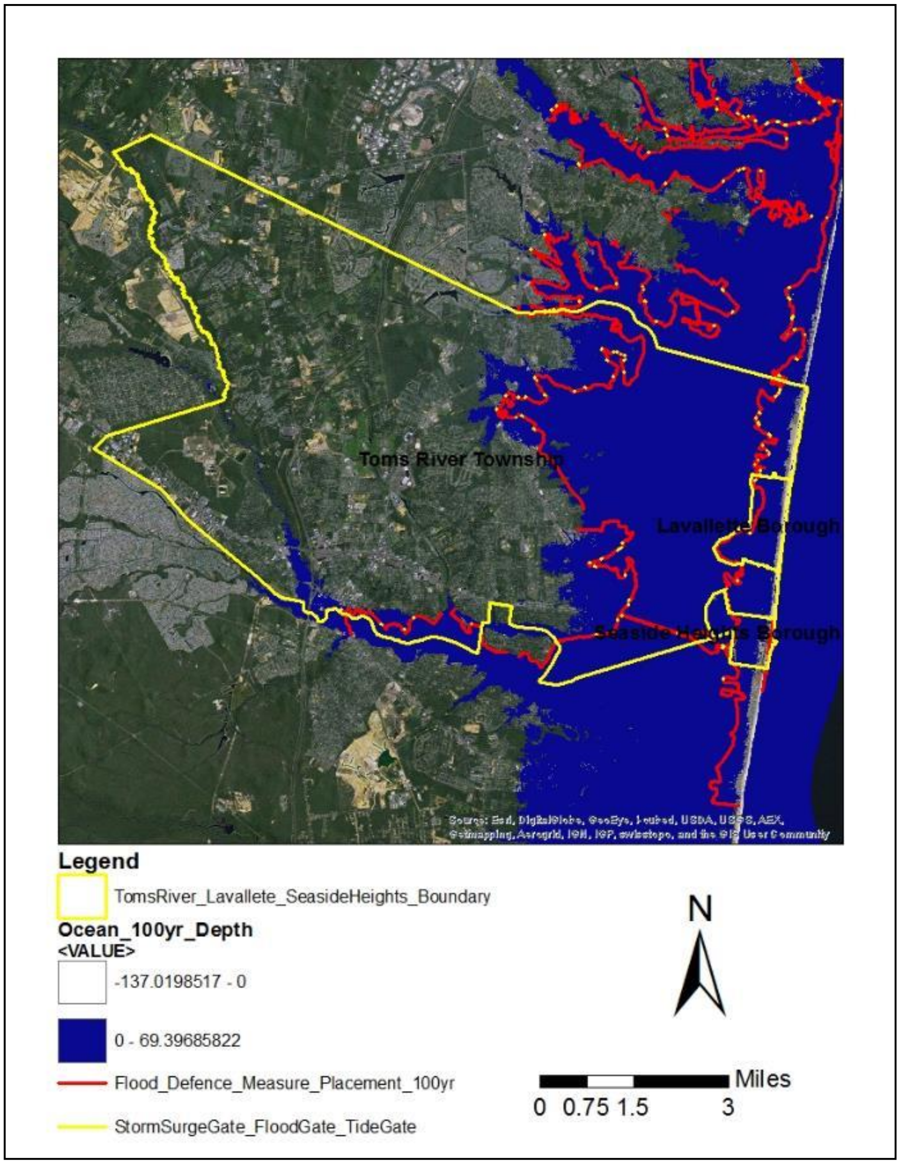


Fig. D3.7 An Overall View of Placement of Flood Defense Measures Based on 100-Year Coastal Flood

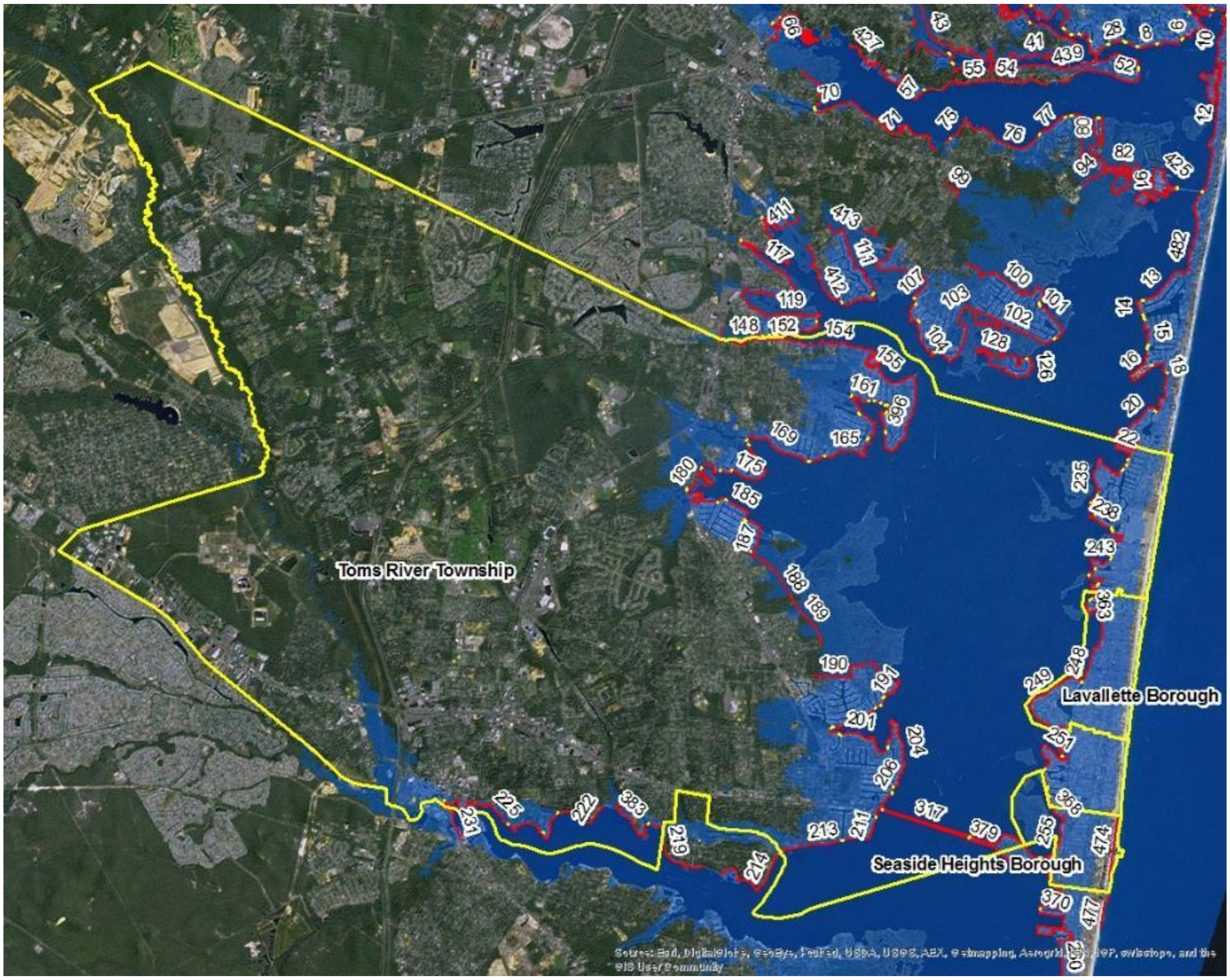


Fig. D3.8 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 100-Year Coastal Flood Defense

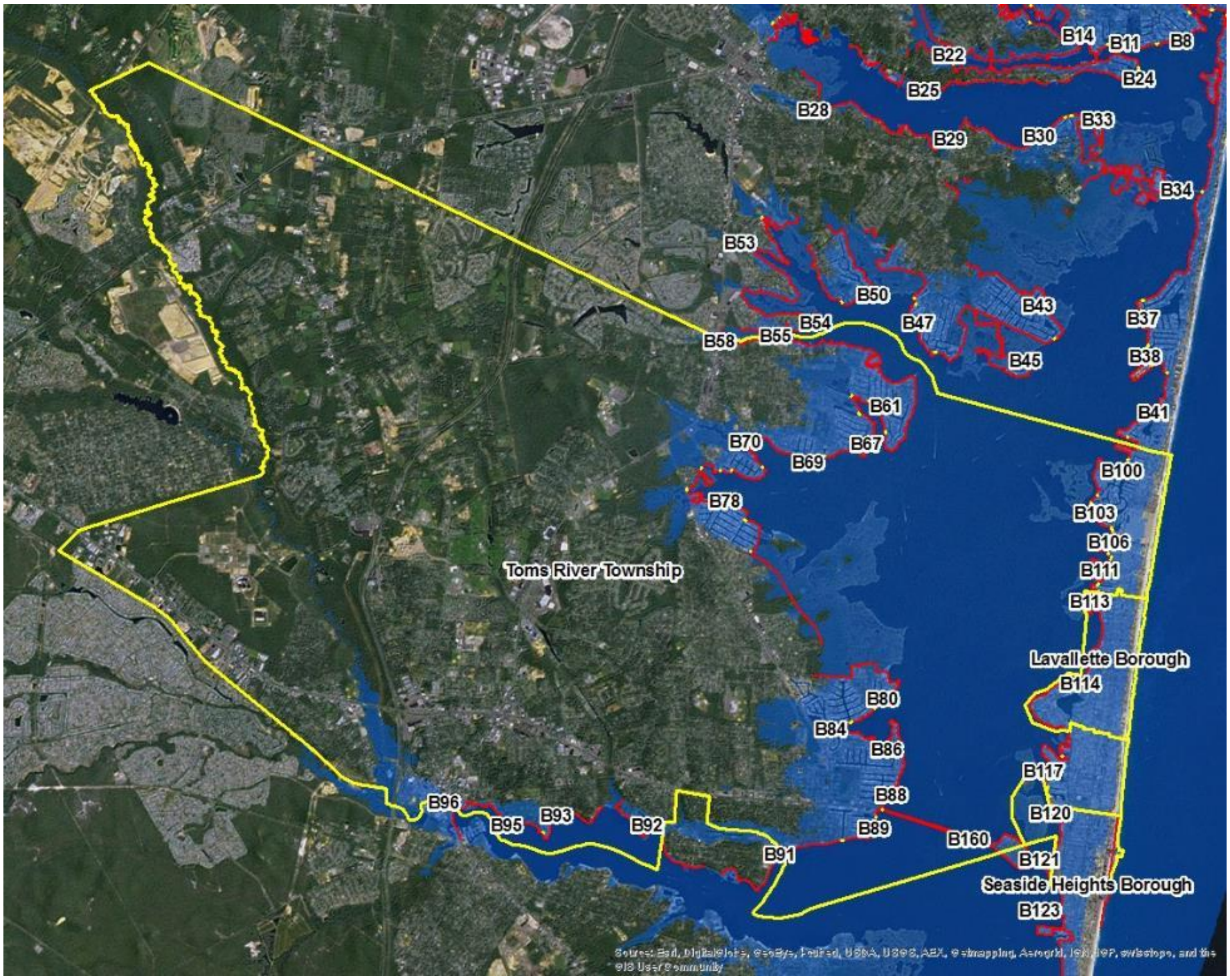


Fig. D3.9 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 100-Year Coastal Flood Defense

D4 Stafford Township

D4.1 Based on 10-Year Coastal Flood

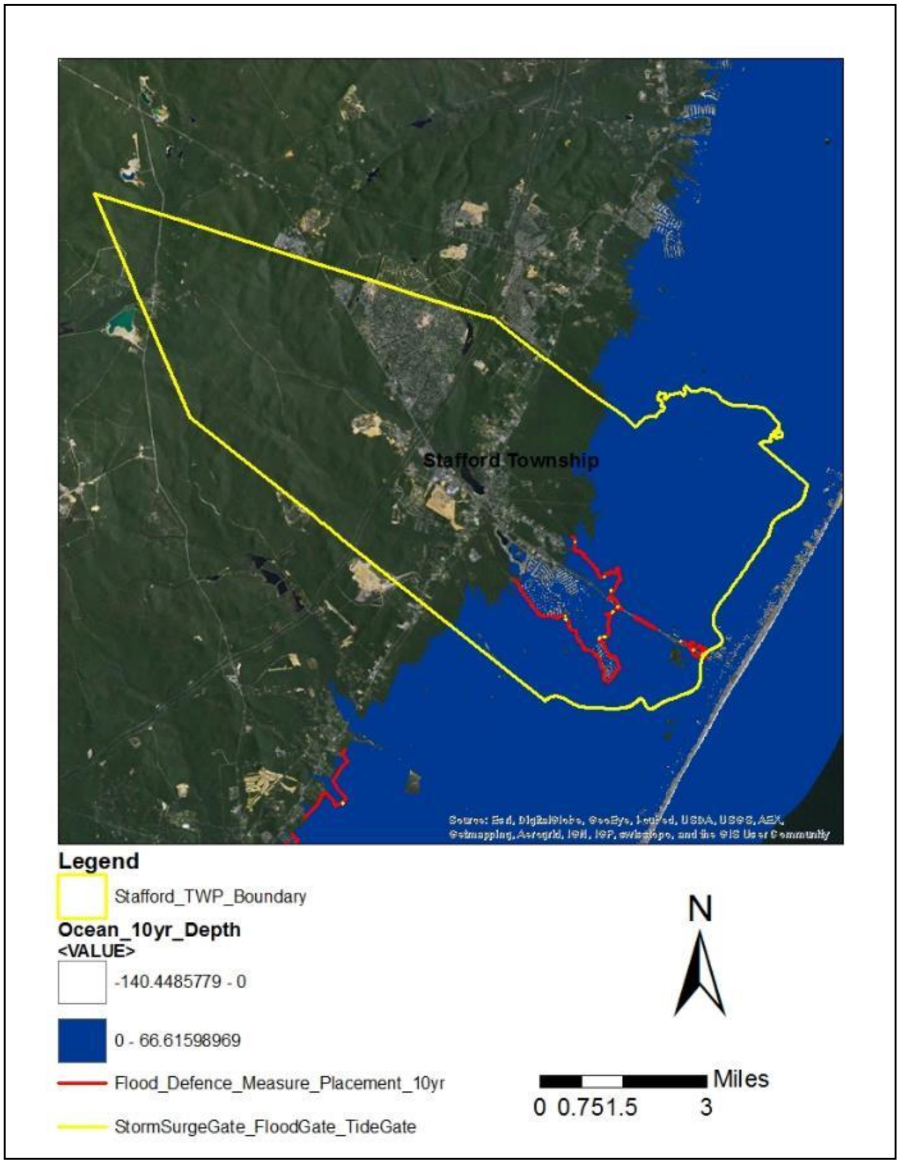


Fig. D4.1 An Overall View of Placement of Flood Defense Measures Based on 10-Year Coastal Flood

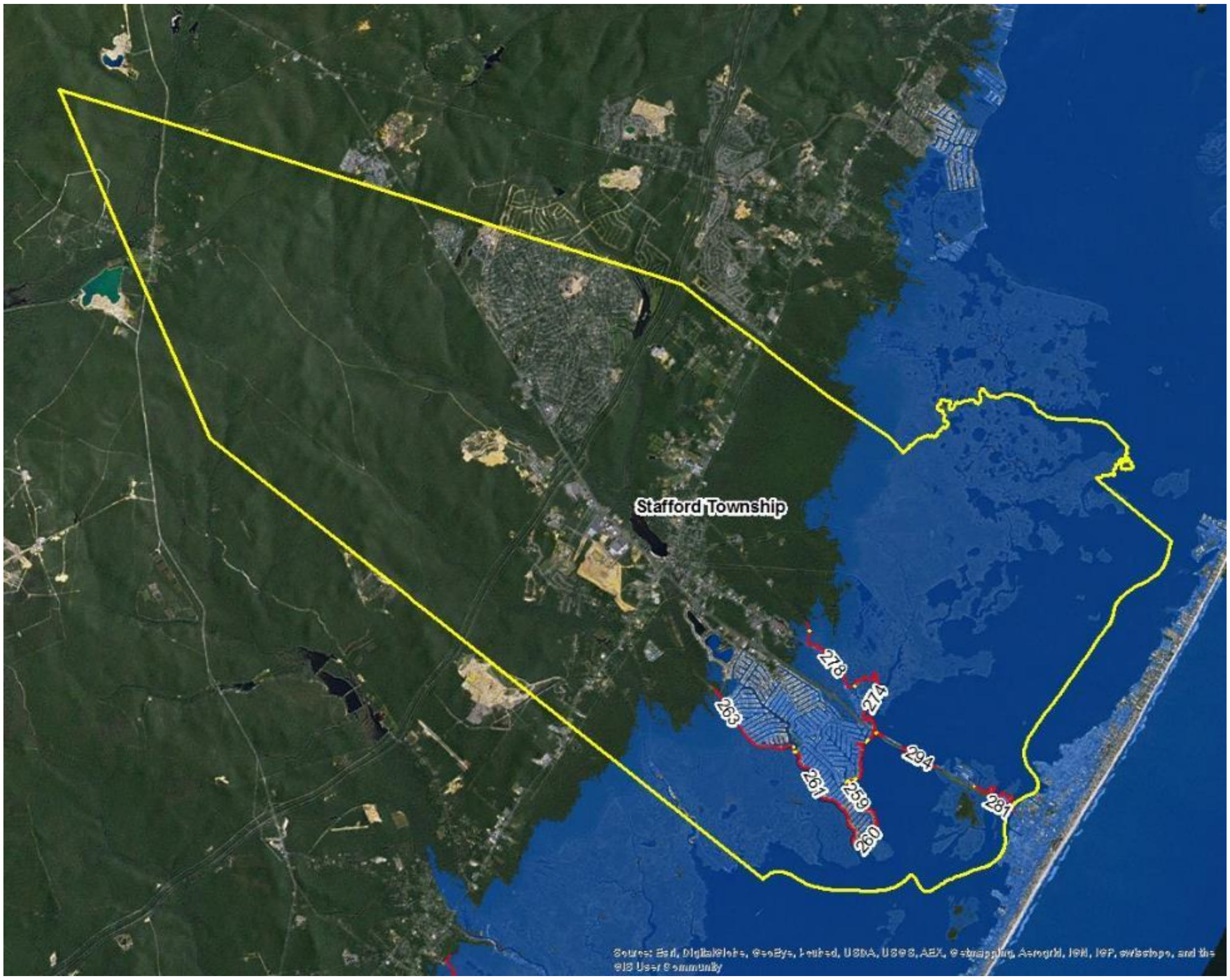


Fig. D4.2 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 10-Year Coastal Flood Defense

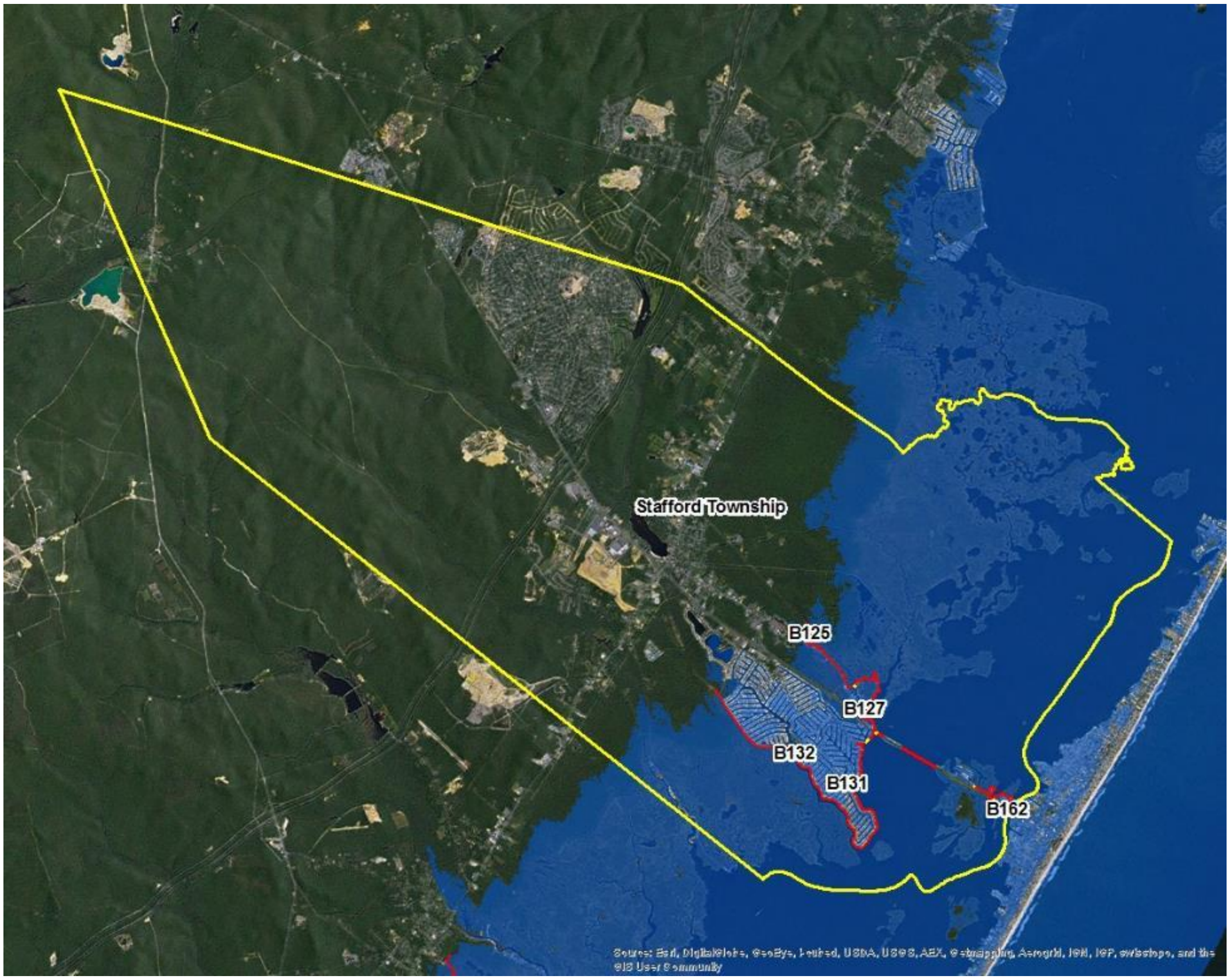


Fig. D4.3 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 10-Year Coastal Flood Defense

D4.2 Based on 50-Year Coastal Flood

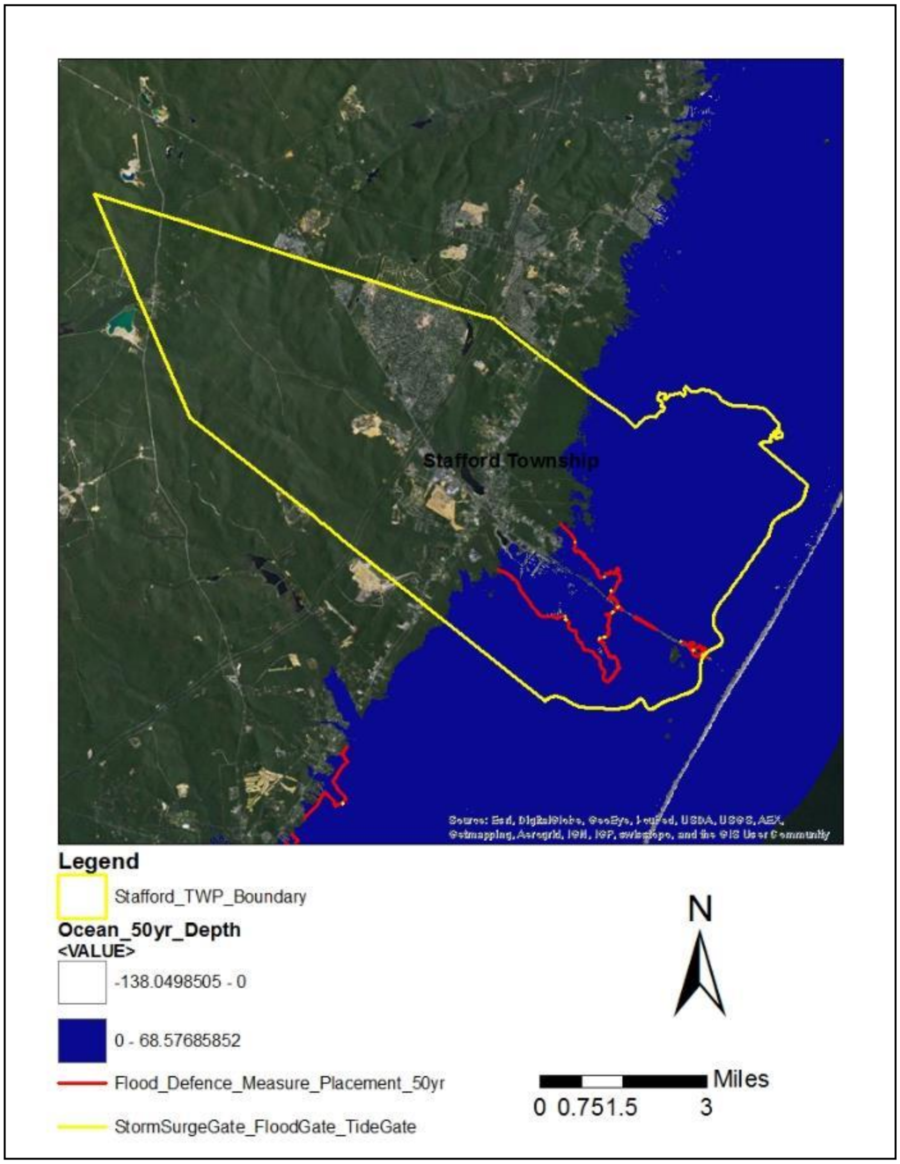


Fig. D4.4 An Overall View of Placement of Flood Defense Measures Based on 50-Year Coastal Flood

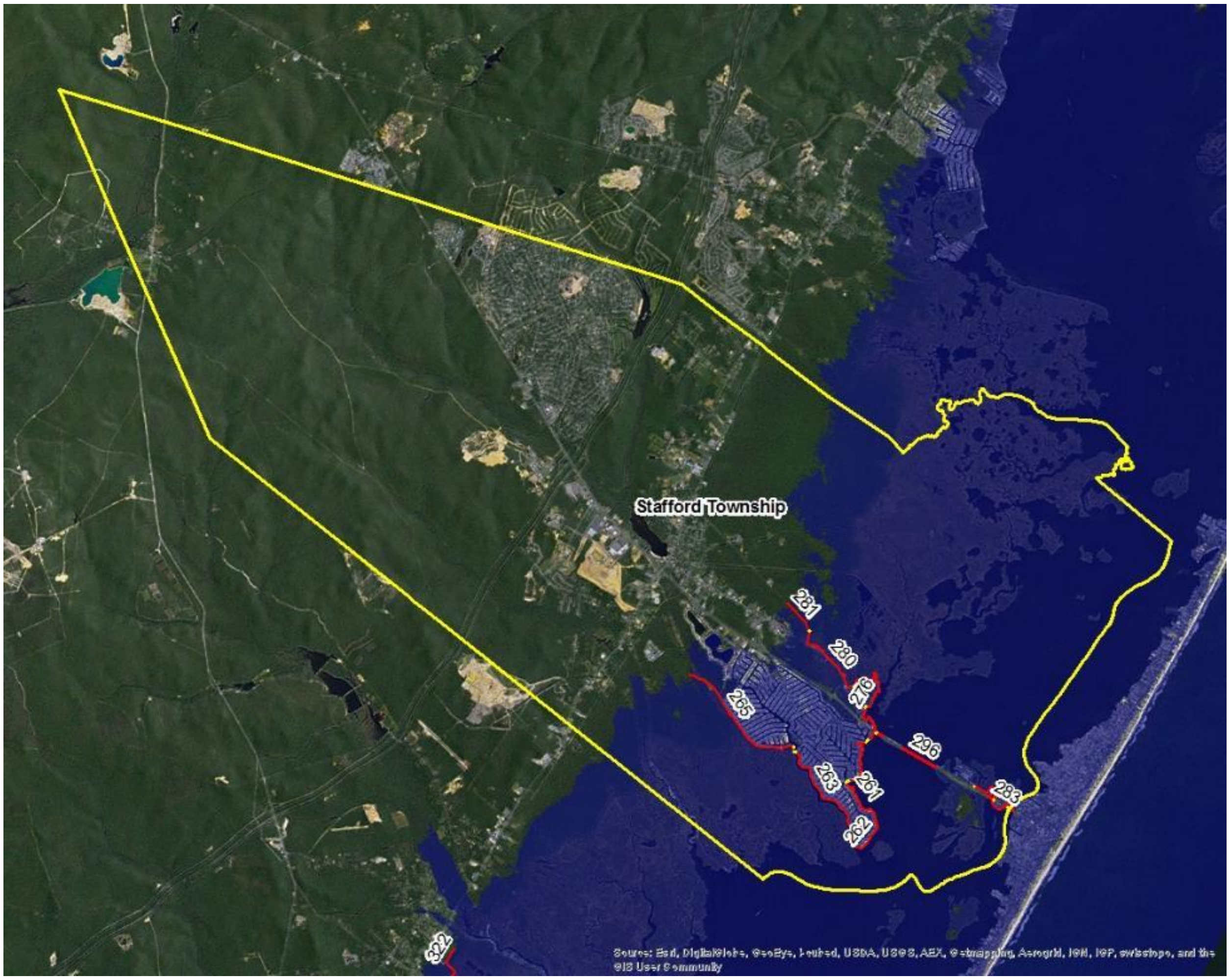


Fig. D4.5 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 50-Year Coastal Flood Defense

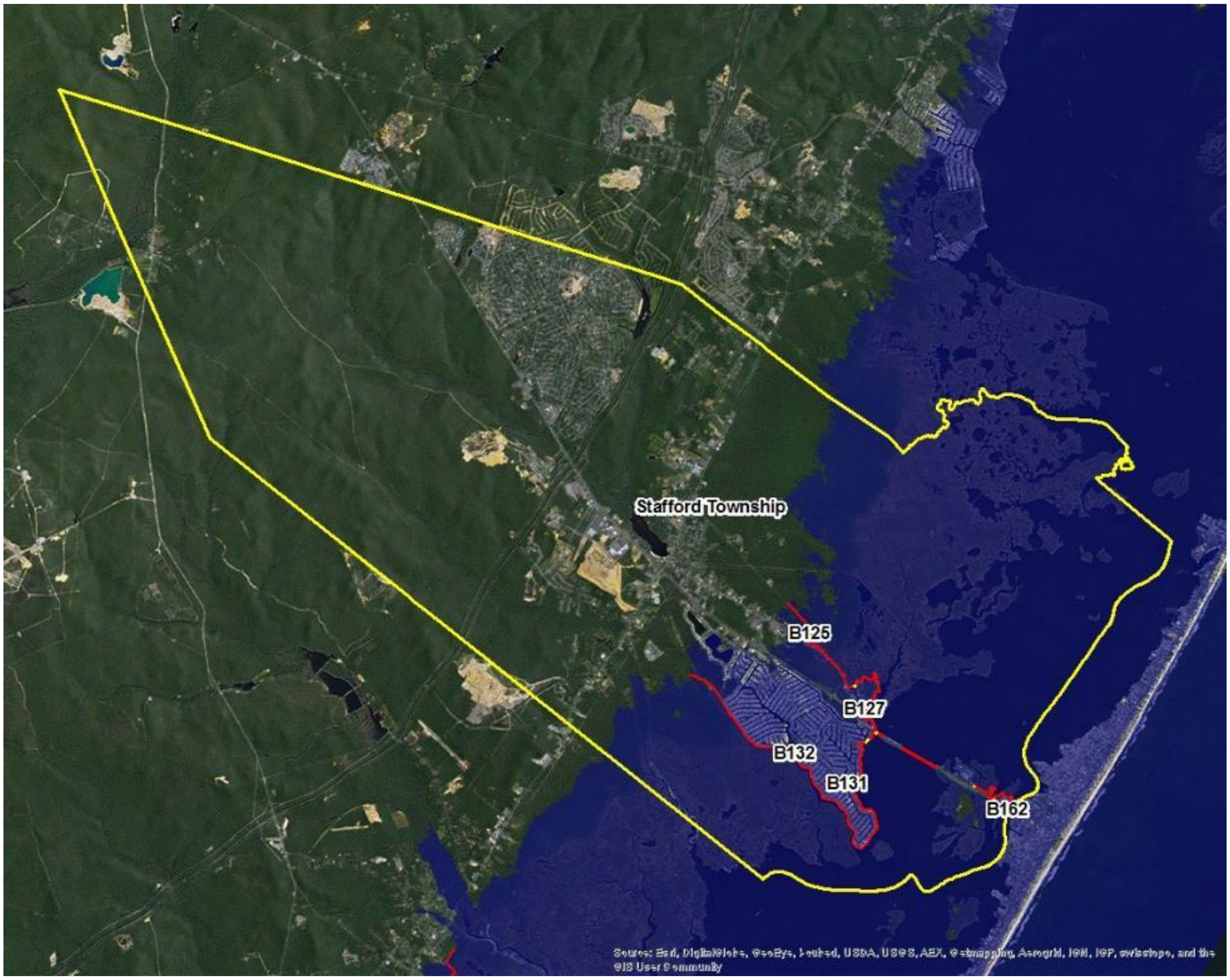


Fig. D4.6 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 50-Year Coastal Flood Defense

D4.3 Based on 100-Year Coastal Flood

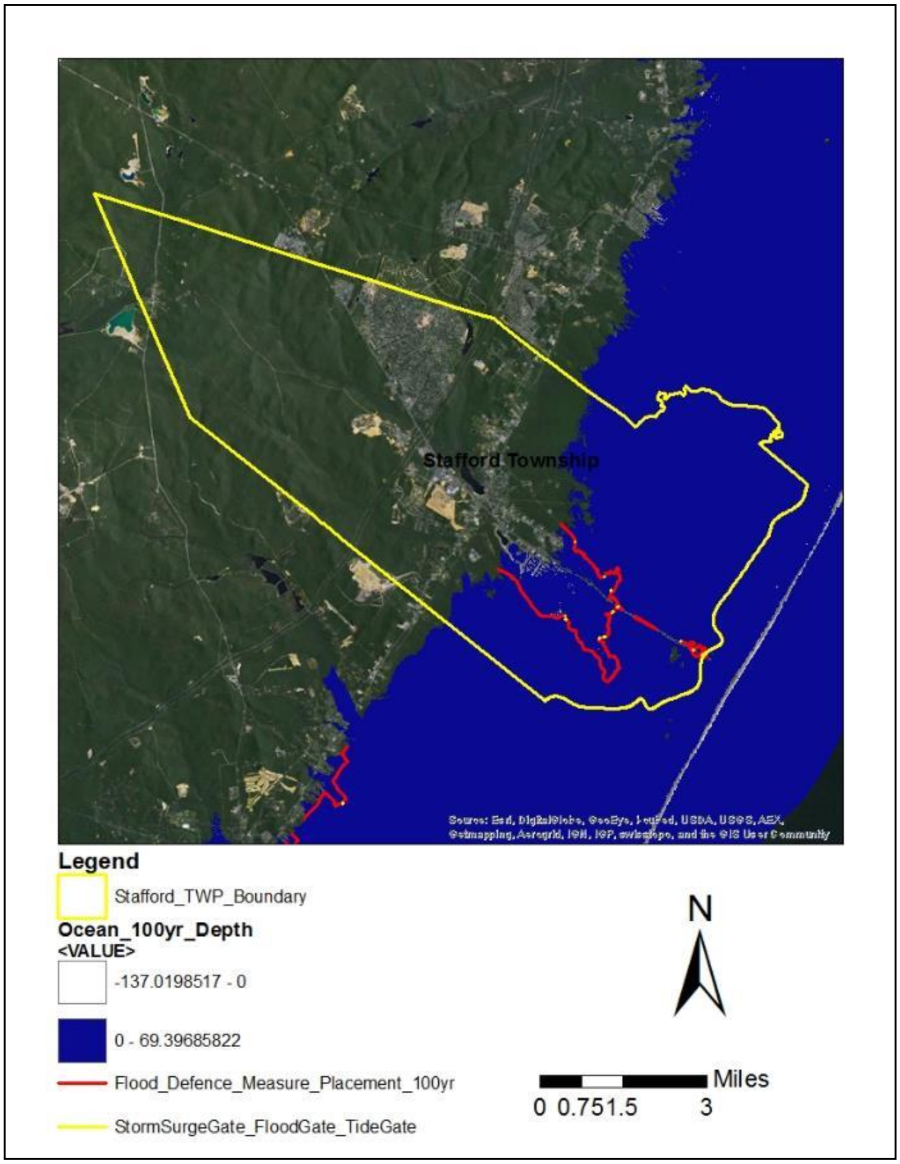


Fig. D4.7 An Overall View of Placement of Flood Defense Measures Based on 100-Year Coastal Flood

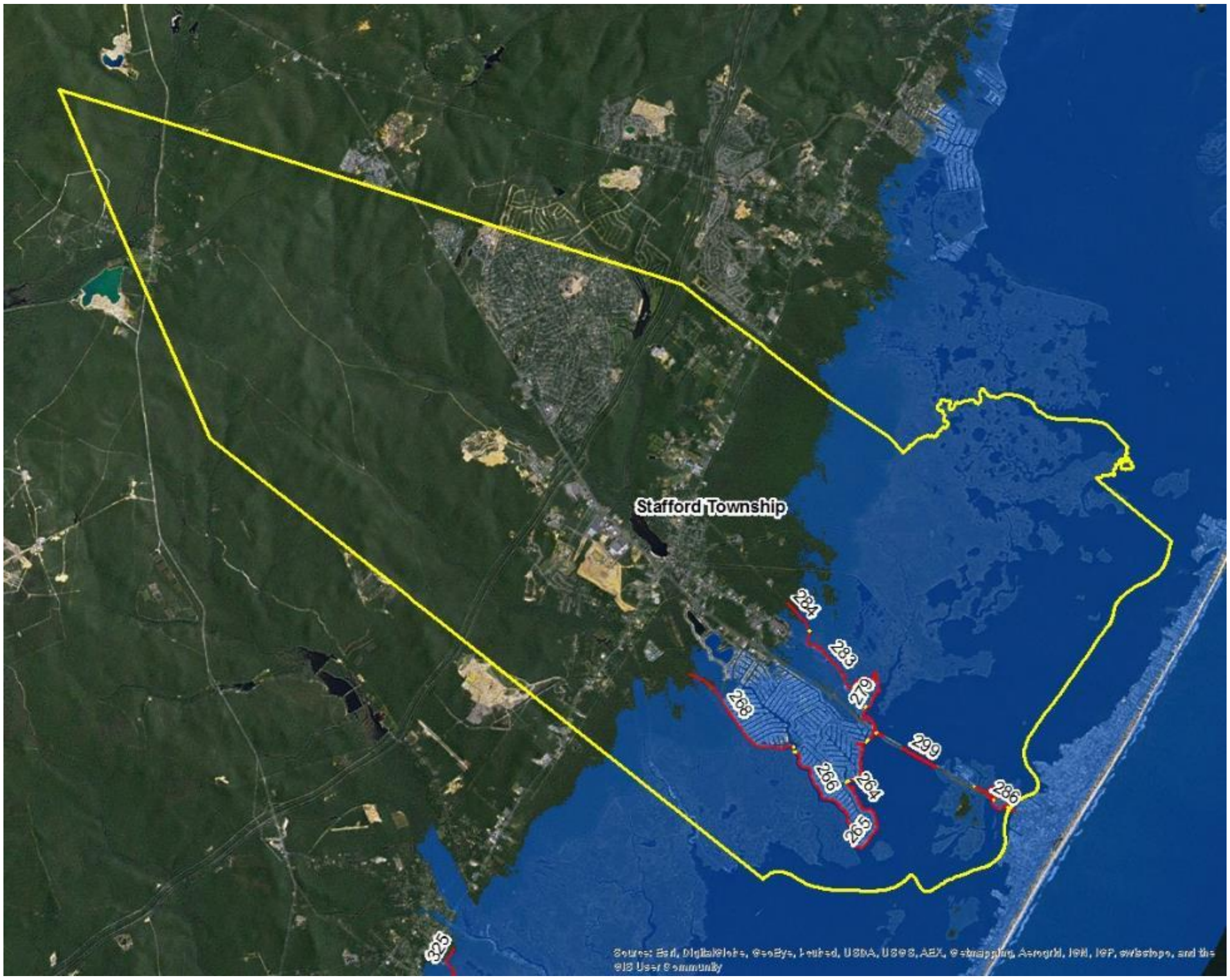


Fig. D4.8 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 100-Year Coastal Flood Defense

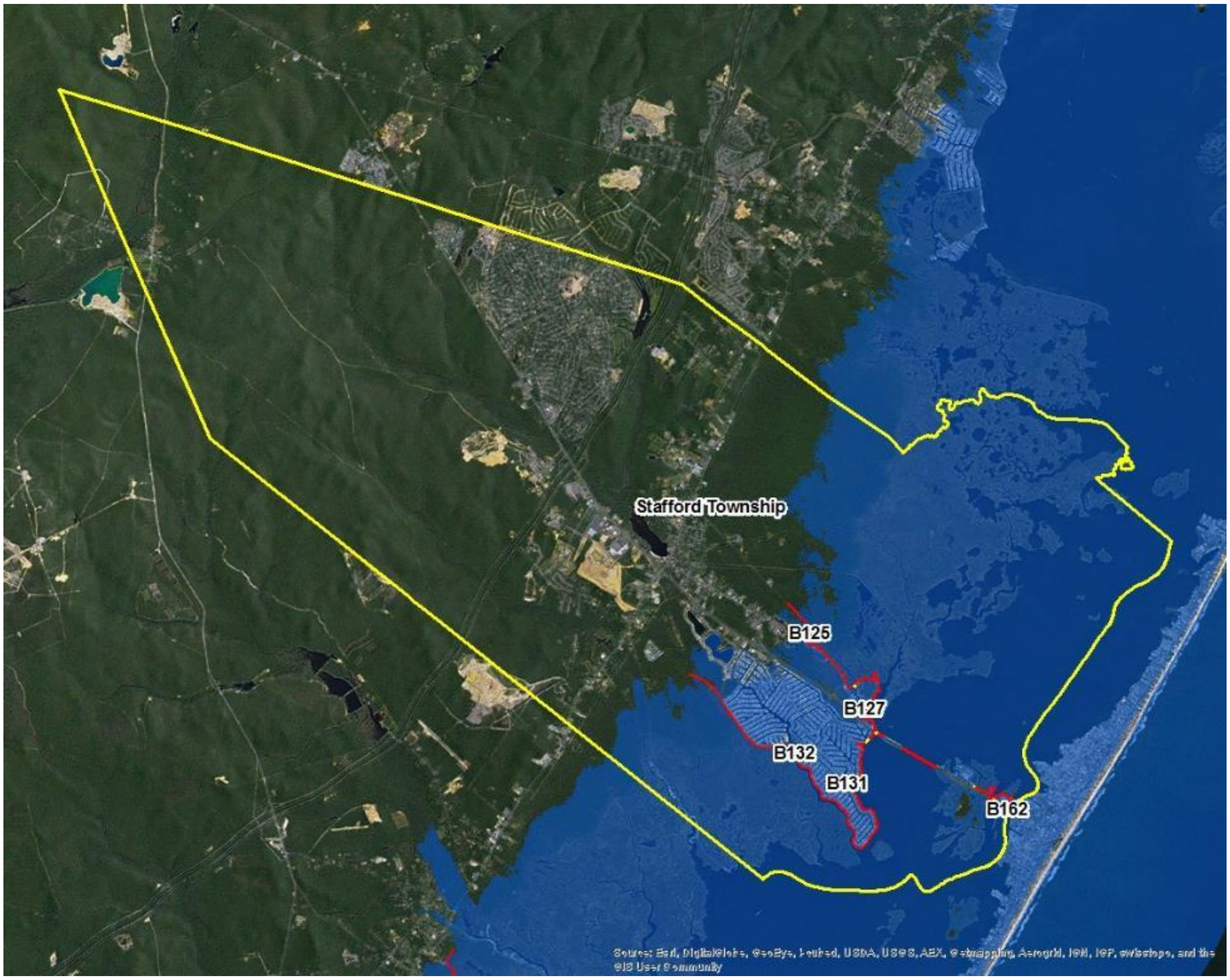


Fig. D4.9 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 100-Year Coastal Flood Defense

D5 Little Egg Harbor Township - including Tuckerton Borough

D5.1 Based on 10-Year Coastal Flood

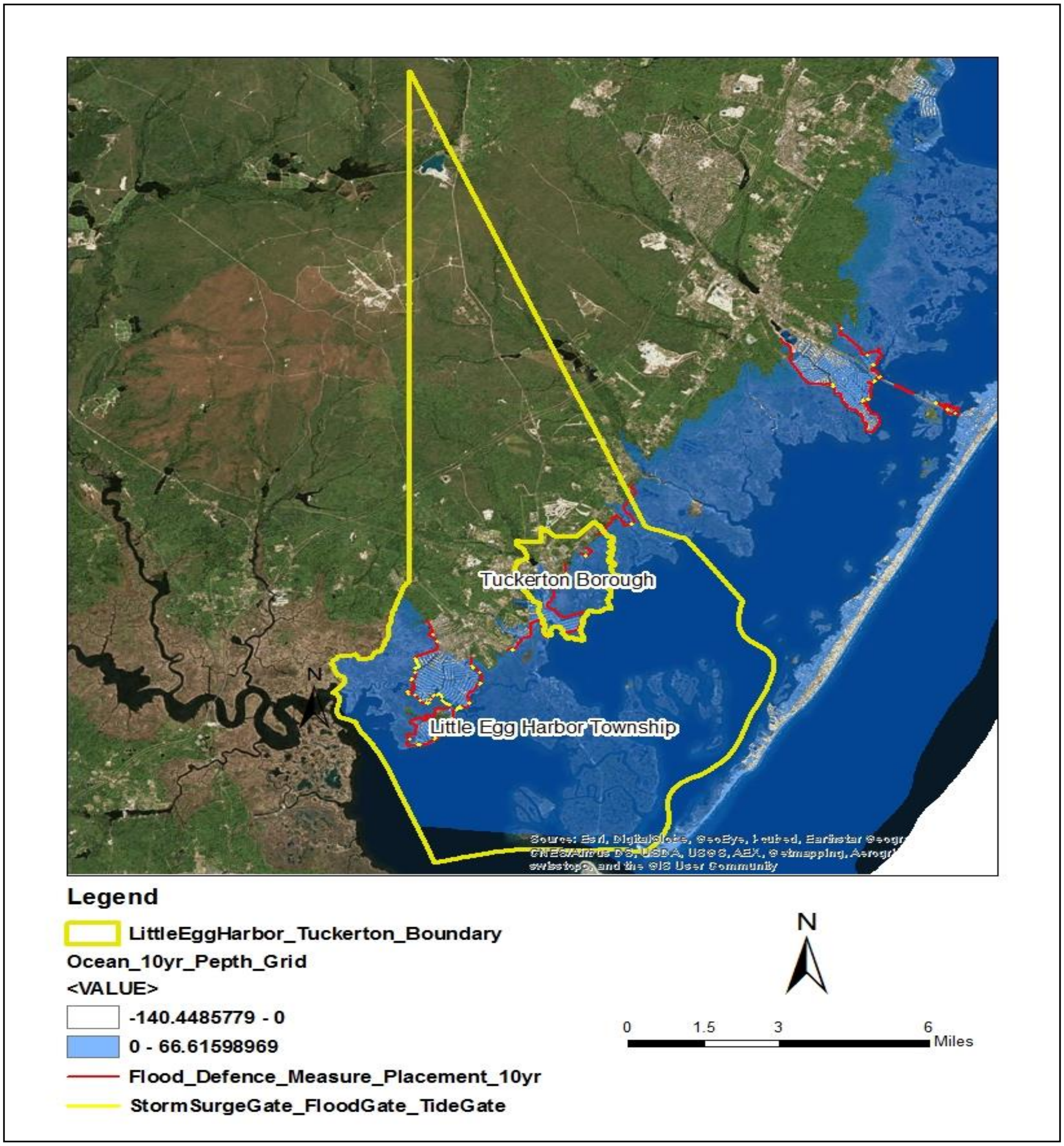


Fig. D5.1 An Overall View of Placement of Flood Defense Measures Based on 10-Year Coastal Flood

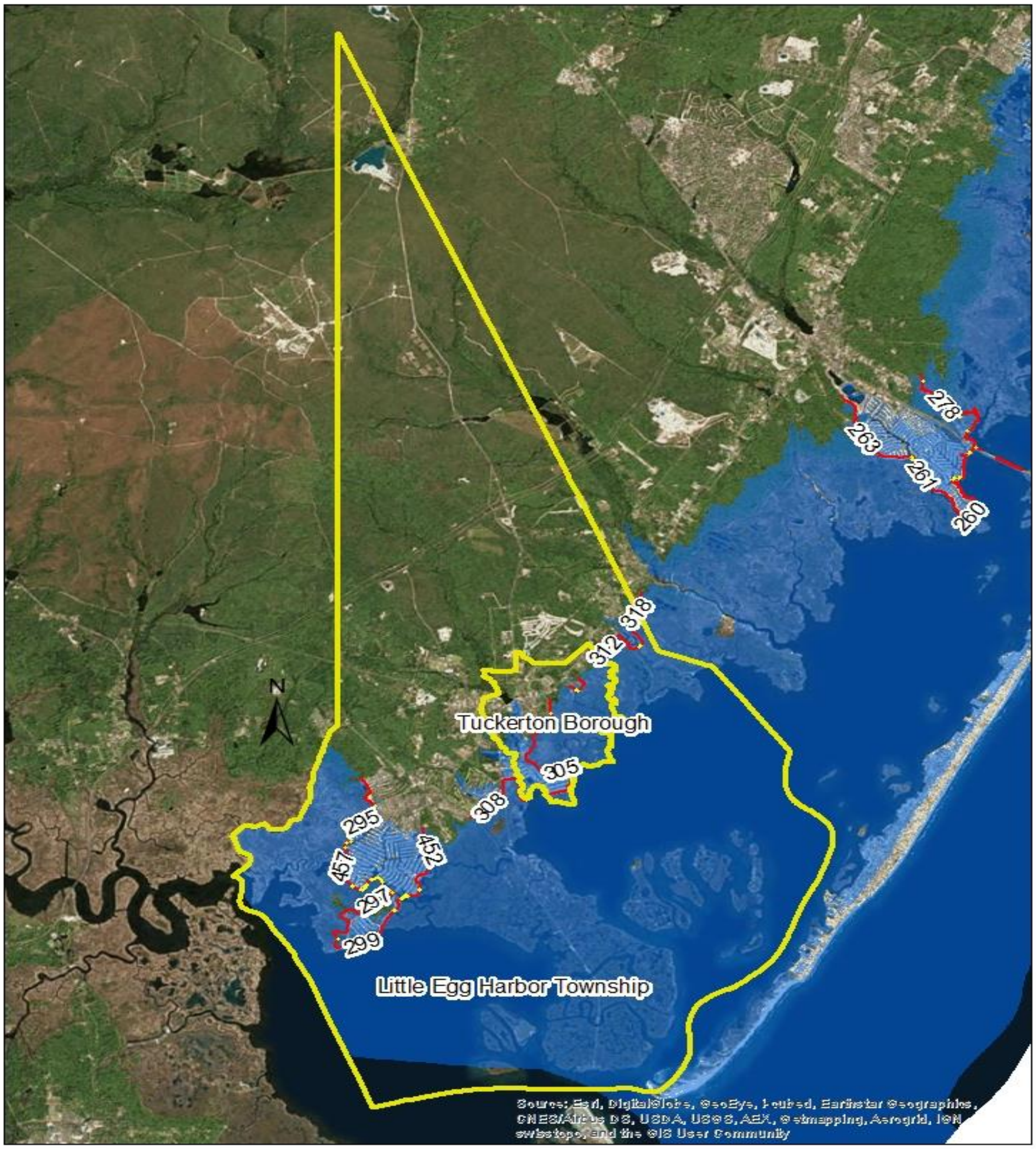


Fig. D5.2 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 10-Year Coastal Flood Defense

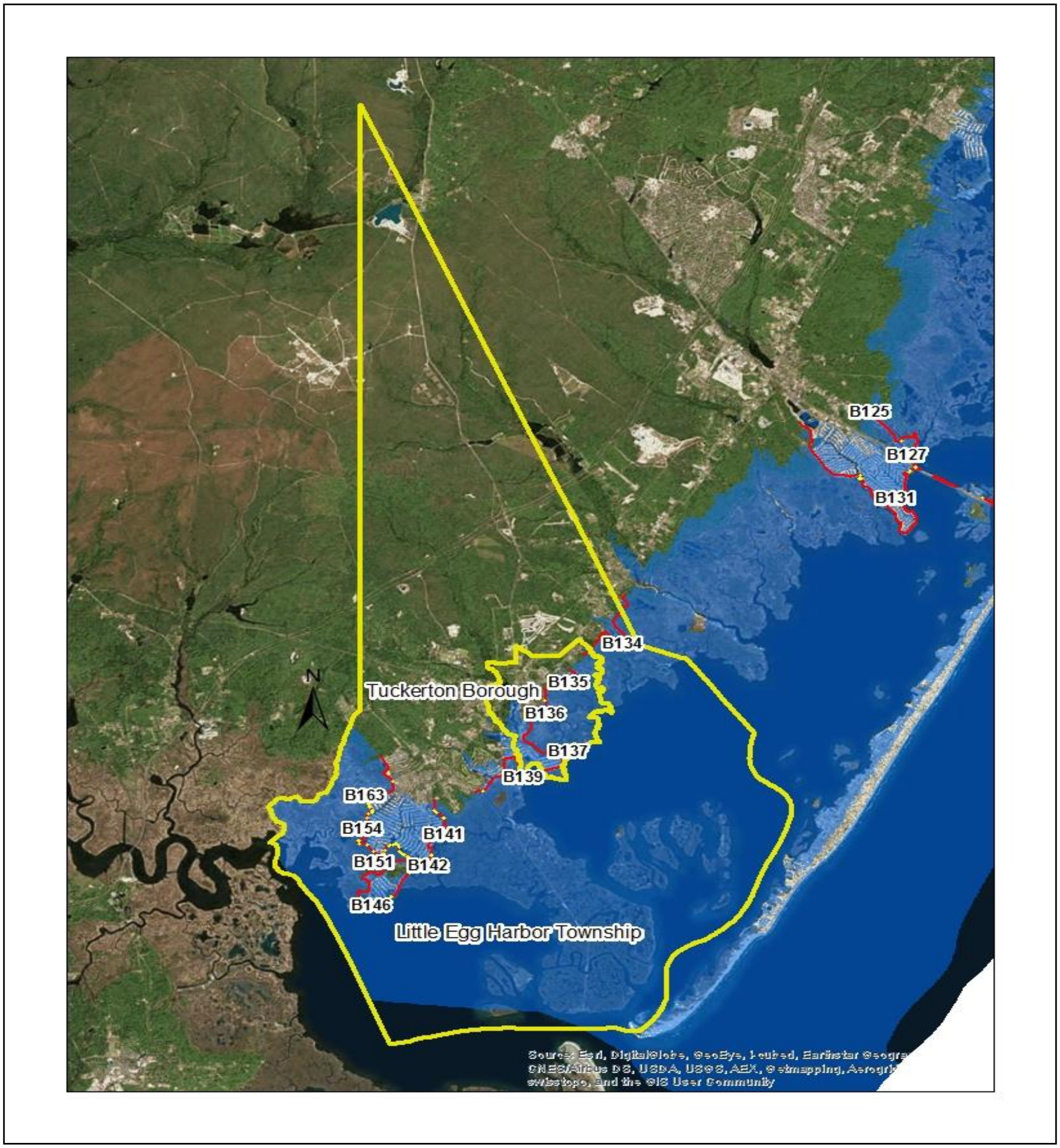


Fig. D5.3 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 10-Year Coastal Flood Defense

D5.2 Based on 50-Year Coastal Flood

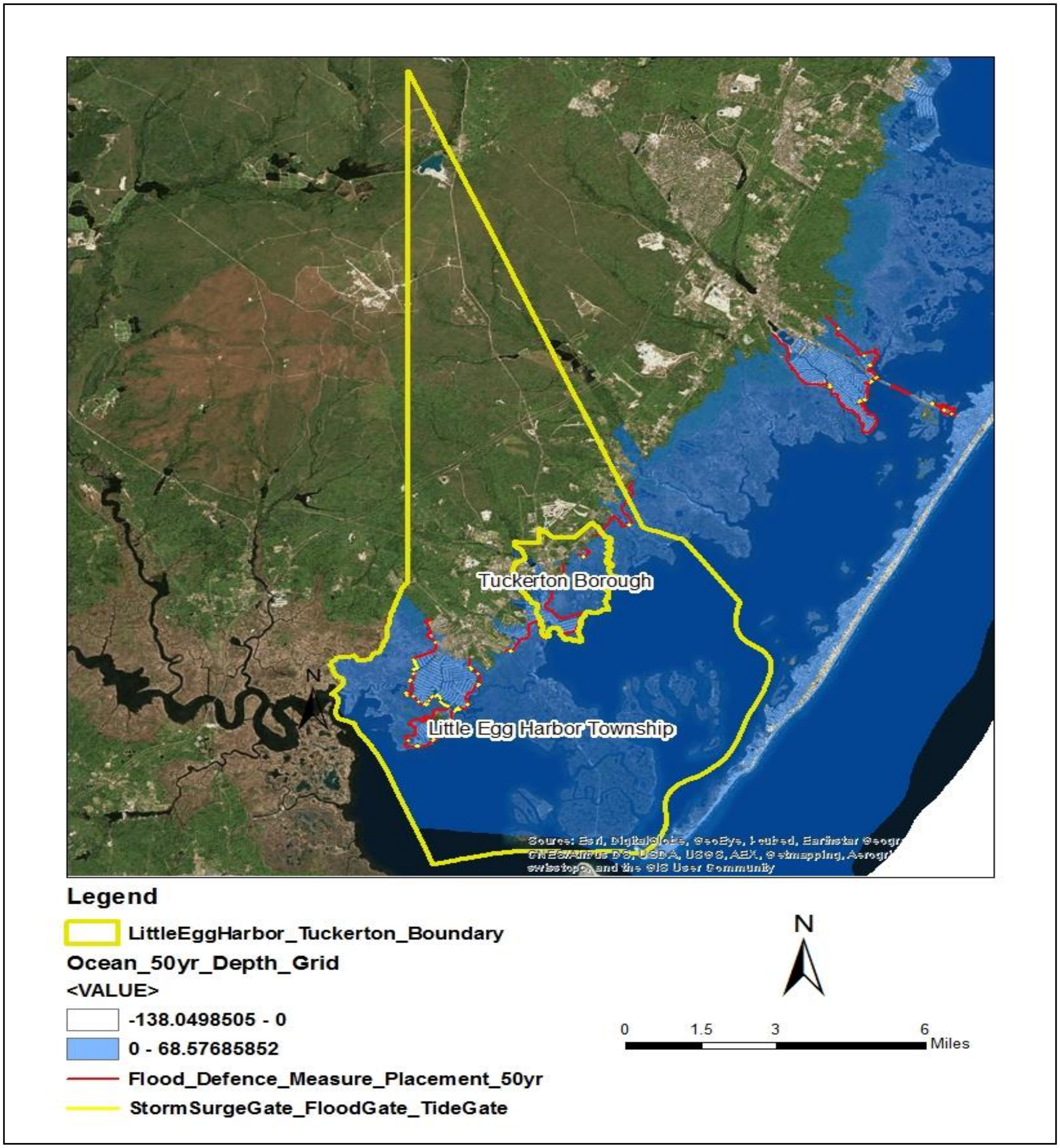


Fig. D5.4 An Overall View of Placement of Flood Defense Measures Based on 50-Year Coastal Flood

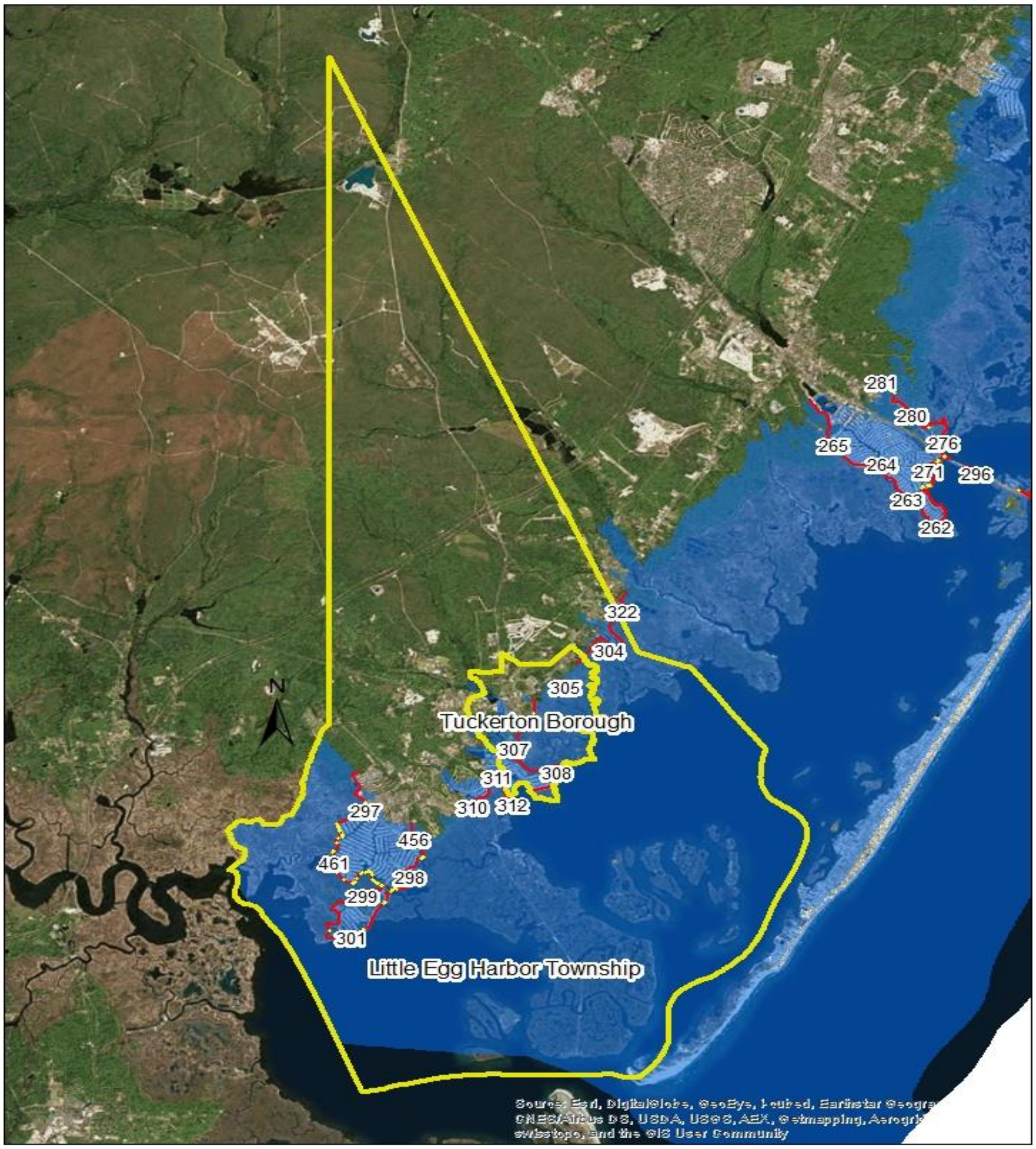


Fig. D5.5 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 50-Year Coastal Flood Defense

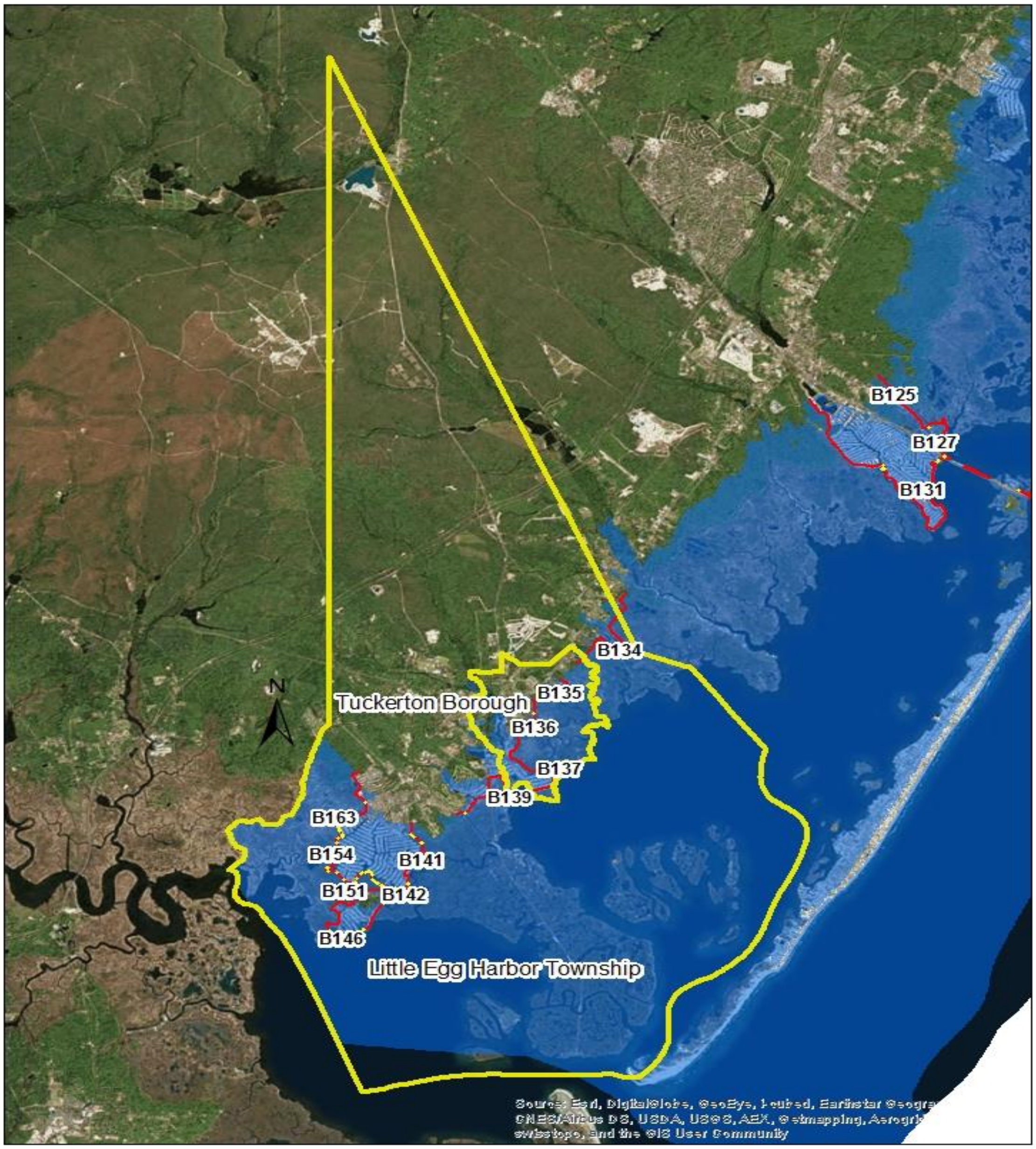


Fig. D5.6 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 50-Year Coastal Flood Defense

D5.3 Based on 100-Year Coastal Flood

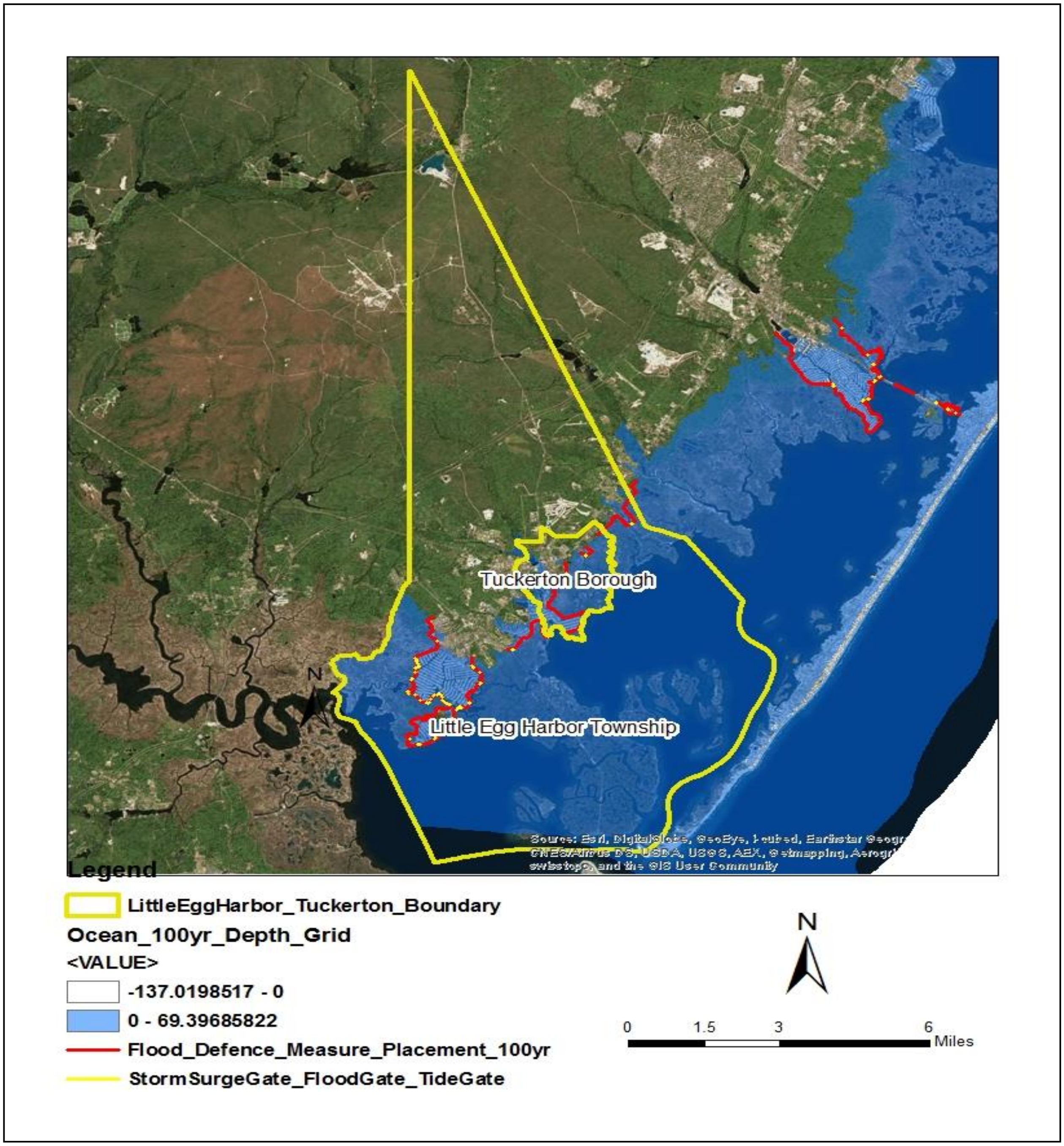


Fig. D5.7 An Overall View of Placement of Flood Defense Measures Based on 100-Year Coastal Flood

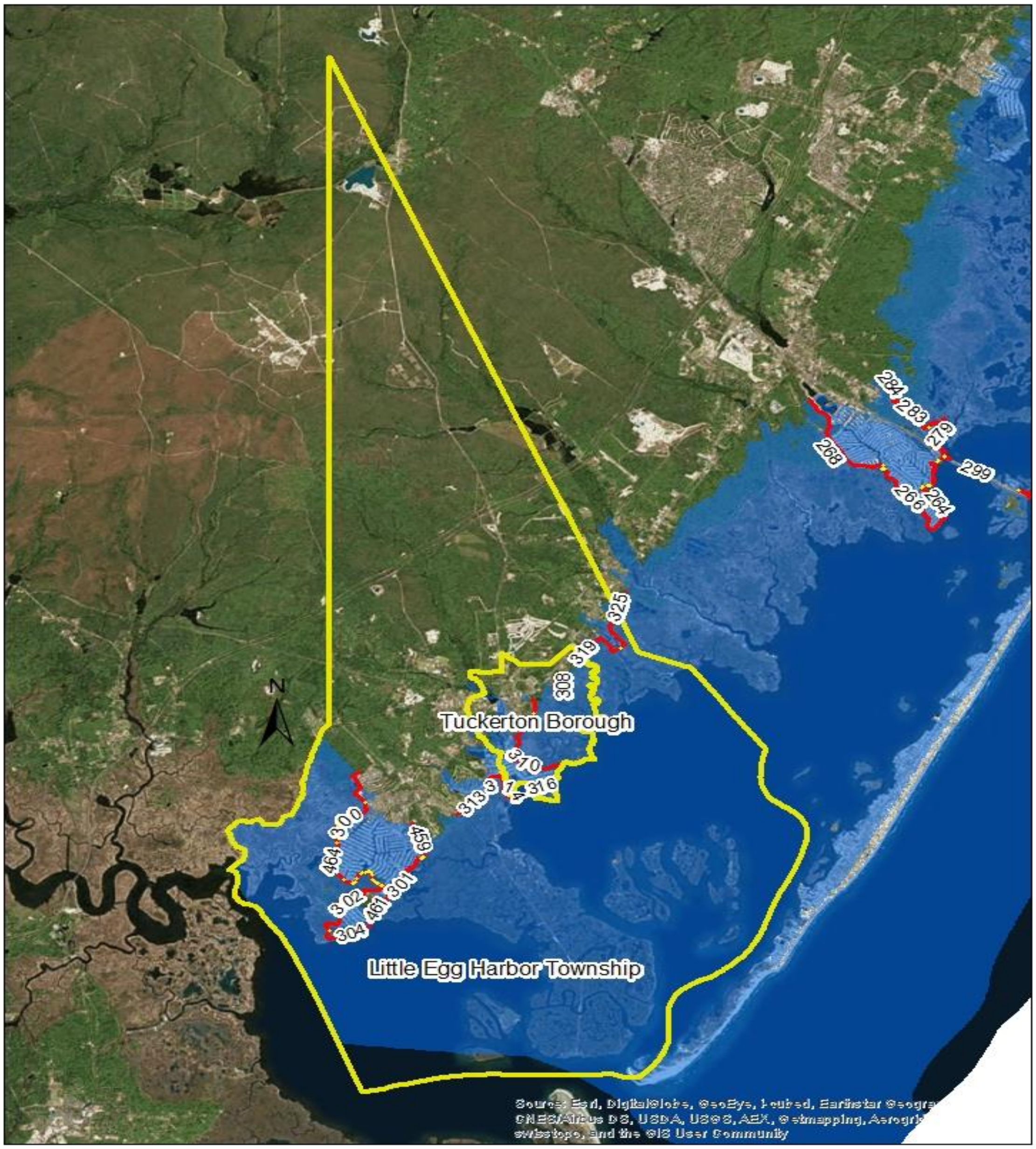


Fig. D5.8 Identification Number and Location of the Proposed Bulkhead, Concrete Floodwall, and Levee, etc. for 100-Year Coastal Flood Defense

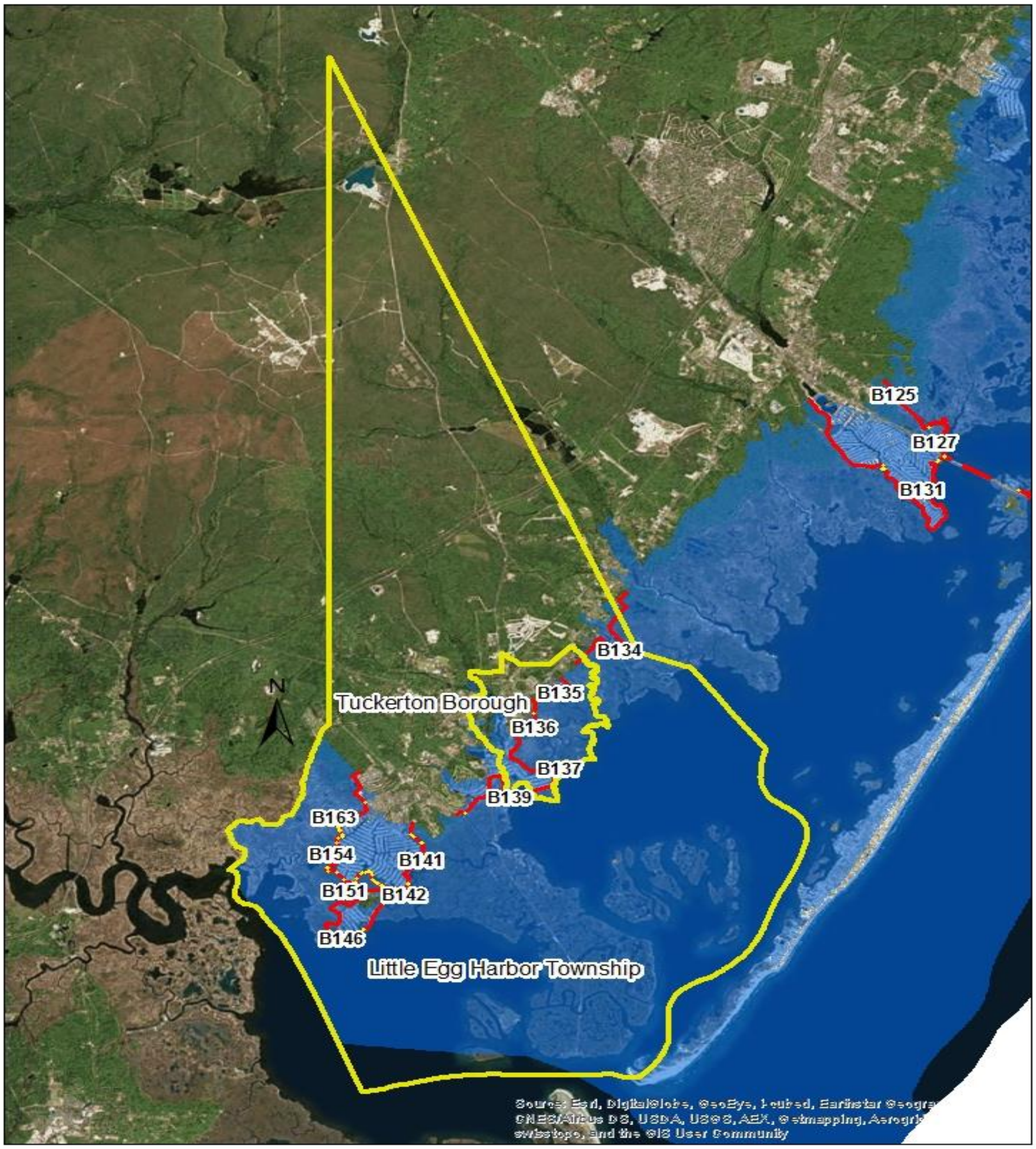


Fig. D5.9 Identification Number and Location of Sluice Gate/In-Water Barrier, Flood Gate, Culvert Flap Gate, etc. for 100-Year Coastal Flood Defense

Appendix E Solution Tables of Flood Defense Alternatives for Each Township or Borough

E1 10-year Coastal Flood Defense Alternatives

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
8	Bay Head Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1178.4	2.63
9	Bay Head Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4095.7	1.59

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
252	Berkeley TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3613.4	1.08
257	Berkeley TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1451.4	1.66
258	Berkeley TWP	Salt mash	Constructing new levee/dike Constructing new concrete flood wall with or without movable panel	2212.6	1.94
314	Berkeley TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1103.3	2.30
316	Berkeley TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	958.3	0.81
317	Berkeley TWP	Pond bank beside bay	Constructing new concrete flood wall with or without removable panel	1373.8	1.32
362	Berkeley TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	410.5	0.00
369	Berkeley TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1248.6	2.53

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
12	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2129.9	1.82
13	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	991.5	1.86
14	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1699.9	0.64
15	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3486.7	0.16
16	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	559.5	0.28
17	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	571.6	2.25
18	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	748.8	0.85
19	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1918.9	1.06
20	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	640.1	1.14
38	Brick TWP	Jordan Rd	Raising roadway Constructing new levee /dike	5702.7	1.79
39	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6158.0	0.91
40	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4314.9	1.61
41	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1381.1	1.49
42	Brick TWP	Vegetated stream bank	Constructing new levee / dike along the stream bank	2406.4	1.10
44	Brick TWP	Mixed wooded wetland	Constructing new levee / dike	577.4	1.64
45	Brick TWP	Salt marsh	Constructing new levee / dike	976.0	1.45
46	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	595.4	1.78
48	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1036.1	1.63
49	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3152.5	1.88
50	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	835.5	1.44
51	Brick TWP	Sand beach bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3564.6	0.78
52	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	937.3	1.27

53	Brick TWP	Sand bank	Constructing new metal sheet bulkhead with or without movable panel	3778.9	0.88
54	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3335.5	1.09
55	Brick TWP	Deciduous brush bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	587.2	1.73
56	Brick TWP	bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1528.7	1.15
57	Brick TWP	Sand bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	797.8	2.13
58	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1443.0	1.44
60	Brick TWP	Dock / shipyard	Constructing removable flood panel	6029.0	2.12
61	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	526.7	1.84
62	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	2520.1	1.90
63	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1450.0	1.82
64	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1434.4	0.59
65	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1145.8	0.73
66	Brick TWP	Mixed wood wetland	Constructing new levee / dike	515.8	0.84
67	Brick TWP	Mixed wood wetland	Constructing new levee / dike	1801.0	1.13
68	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	537.8	1.50
69	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5703.3	1.20
70	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3292.1	1.29
72	Brick TWP	Salt marsh	Constructing new levee / dike	420.8	1.23
73	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	383.9	0.38
74	Brick TWP	Sand beach bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2576.8	1.77
75	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3819.3	0.68
76	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1899.8	0.68
77	Brick TWP	Sand bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	323.6	2.06
78	Brick TWP	Shrub wetlands	Constructing new levee / dike	1538.1	0.82
79	Brick TWP	Shrub wetlands	Constructing new levee / dike	3913.7	1.76
80	Brick TWP	Shrub wetlands	Constructing new levee / dike	1671.2	1.38

			Raising roadway		
81	Brick TWP	Shrub wetlands	Constructing new levee / dike	2699.6	1.35
82	Brick TWP	Dock / shipyard	Constructing removable flood panel	2757.0	1.87
83	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1417.7	1.6
84	Brick TWP	Salt marsh	Constructing new levee / dike	779.0	1.49
85	Brick TWP	Roadway edge	Constructing new levee / dike Constructing new concrete flood wall with or without movable panel	760.1	0.45
86	Brick TWP	Wooded wetland	Constructing new levee / dike Raising residence	278.6	0.39
87	Brick TWP	Roadway edge	Constructing new levee / dike Raising roadway	977.5	1.43
88	Brick TWP	Roadway edge	Constructing new levee / dike Raising roadway	819.9	1.15
89	Brick TWP	Wooded wetland	Constructing new levee / dike Raising residence	557.1	0.67
90	Brick TWP	Wooded wetland	Constructing new levee / dike	3475.5	1.17
91	Brick TWP	Mantoloking Rd edge	Constructing new concrete flood wall with or without removable panel	241.9	0.00
96	Brick TWP	Salt marsh	Constructing new levee / dike	5091.5	1.19
97	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1116.0	1.49
98	Brick TWP	Roadway edge	Raising roadway Constructing new levee / dike	4213.9	1.92
99	Brick TWP	Roadway edge	Raising roadway Constructing new levee / dike	3552.8	1.74
100	Brick TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1642.4	1.08
101	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1726.5	1.33
102	Brick TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	432.8	2.27
103	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	991.0	1.68
104	Brick TWP	Coniferous forest	Constructing new levee / dike	2179.0	0.60

107	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3284.3	2.29
108	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2380.4	1.42
110	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1634.0	0.39
111	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2764.4	1.42
112	Brick TWP	Coniferous forest	Constructing new levee / dike	4903.9	1.33
115	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1838.6	1.21
116	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	281.3	0.84
117	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	275.1	0.88
118	Brick TWP	Coniferous forest	Constructing new levee / dike Constructing new concrete flood wall with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	1707.6	0.00
121	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3228.8	1.39
122	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Raising residences	1128.6	2.07
123	Brick TWP	Salt marsh	Constructing new levee / dike	3577.5	1.87
124	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1307.2	0.97
125	Brick TWP	Roadway	Raising roadway Constructing new levee / dike	3061.3	1.27
126	Brick TWP	Roadway edge	Raising roadway Constructing new levee / dike	3759.6	1.71
127	Brick TWP	Salt marsh	Constructing new levee / dike	137.4	2.3
128	Brick TWP	Roadway along bay	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	723.9	1.86
129	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	696.2	1.39
132	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2444.7	2.70
133	Brick TWP	Dock / shipyard	Constructing removable flood panel	2514.0	2.06
134	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1845.2	2.04
135	Brick TWP	Herbertsville Rd edge	Constructing new concrete flood wall above culvert	260.5	0.61

136	Brick TWP	Wooded wetland	Constructing new levee / dike	578.3	0.00
137	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1967.9	2.46
138	Brick TWP	Vegetated earth bank	Constructing new concrete flood wall with or without removable panel Raising residences	412.0	2.00
139	Brick TWP	Mixed wooded wetland	Constructing new levee / dike Raising residence	301.5	2.67
141	Brick TWP	Beverly Beach Rd edge	Constructing new concrete flood wall along shoulder	684.9	0.44
142	Brick TWP	Beverly Beach Rd edge	Constructing new concrete flood wall along shoulder	560.7	0.38
330	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	462.4	1.62
334	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3043.5	0.91
335	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	937.7	1.51
337	Brick TWP	Midstreams Rd edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	931.0	0.50
338	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	924.6	2.12
339	Brick TWP	Bay bank	Constructing new metal sheet with or without movable panel Constructing new concrete flood wall with or without movable panel	521.7	1.11
340	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	307.4	1.26
341	Brick TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	201.7	2.04
342	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1165.5	1.58
343	Brick TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	580.7	2.49
344	Brick TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	259.3	1.37
394	Brick TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	574.3	1.41
395	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	976.6	1.24

396	Brick TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	442.7	1.79
397	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	537.5	1.38
398	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	587.2	0.65
399	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1320.3	1.87
400	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1727.7	1.23
401	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	593.2	1.91
402	Brick TWP	Coniferous forest	Constructing new levee / dike	86.7	1.54
403	Brick TWP	Dock / shipyard	Constructing removable flood panel	555.3	1.56
404	Brick TWP	Coniferous forest	Constructing new levee / dike	1067.2	1.3
405	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2355.1	0.97
406	Brick TWP	Coniferous forest	Constructing new levee / dike	2092.0	1.05
408	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	969.6	2.03
409	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	991.6	0.69
410	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	606.3	1.61
411	Brick TWP	Roadway edge	Constructing new levee / dike	762.8	1.88
412	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	480.8	1.18
413	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	821.1	0.20
414	Brick TWP	Salt marsh	Constructing new levee / dike	863.7	1.64
415	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1398.8	1.18
416	Brick TWP	Salt marsh	Constructing new levee / dike	751.7	0.69
417	Brick TWP	Shrub wetland	Constructing new levee / dike	1021.9	1.65
418	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2637.2	1.05
419	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1524.4	0.35
420	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1351.5	1.42
421	Brick TWP	Salt marsh	Constructing new levee / dike	501.1	0.87
422	Brick TWP	Salt marsh	Constructing new levee / dike	967.5	0.00
423	Brick TWP	Dock / shipyard	Constructing removable flood panel	1070.6	0.45

424	Brick TWP	Roadway edge	Constructing new levee / dike	766.0	1.38
425	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	703.6	1.34
426	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1329.2	1.49
427	Brick TWP	sand beach bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	737.8	2.20
428	Brick TWP	Bridge	Constructing movable or removable flood panel	193.8	1.54
429	Brick TWP	Bridge	Constructing movable or removable flood panel	205.8	0.61
430	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1014.4	1.14
431	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead t with or without movable panel Constructing new concrete flood wall with or without movable panel	247.0	2.44
432	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2856.3	0.81
433	Brick TWP	Bridge	Constructing movable or removable flood panel	135.1	1.33
434	Brick TWP	Bridge	Constructing movable or removable flood panel	117.5	1.33
435	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	902.1	1.78
436	Brick TWP	Midstreams Rd edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	277.3	0.00
437	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	421.6	1.80
442	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1353.1	4.18
465	Brick TWP	Vegetated stream bank	Constructing new levee / dike along the stream bank	1103.1	0.75
466	Brick TWP	Wooded wetland	Constructing new levee / dike Raising residences (2 Units)	295.5	0.62
467	Brick TWP	Mixed wooded wetland	Constructing new levee / dike	326.2	1.74
470	Brick TWP	Wooded wetland	Constructing new levee / dike	1817.3	0.61
472	Brick TWP	Coniferous forest	Constructing new levee / dike	970.3	1.49
473	Brick TWP	Coniferous forest	Constructing new levee / dike	659.9	0.12
474	Brick TWP	Coniferous forest	Constructing new levee / dike	1190.2	1.41

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
318	Eagleswood TWP	Upland rights-of-way undeveloped	Constructing new levee / dike over upland	3778.6	2.93

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
209	Island Heights Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2118.2	1.34
210	Island Heights Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1191.5	1.48
211	Island Heights Boro.	Dock/shipyard	Constructing movable or removable flood panel	463.3	1.19
212	Island Heights Boro.	Dock/shipyard	Constructing movable or removable flood panel	510.5	0.13
213	Island Heights Boro.	Dock/shipyard	Constructing movable or removable flood panel	521.5	1.07
214	Island Heights Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3930.2	1.34
375	Island Heights Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	465.3	1.51

OBJECTID	Mun_Name	Existing_Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
242	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	582.7	1.78
243	Lavallette Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3828.6	1.42
244	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6026.3	0.61
356	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1285.8	1.47
357	Lavallette Boro.	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	617.1	1.59
358	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	227.3	1.55

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
295	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	9263.4	3.60
296	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	4504.1	6.37
297	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	16000.3	4.48
298	Little Egg Harbor TWP	Salt marsh	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1554.4	4.03
299	Little Egg Harbor TWP	Salt marsh	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1987.5	3.58
300	Little Egg Harbor TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1017.1	3.33
301	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike alone roadway Raising roadway (Dock St)	2562.3	3.94
302	Little Egg Harbor TWP	Shrub wetland	Constructing new levee / dike	2998.1	1.51
307	Little Egg Harbor TWP	Wooded wetland	Constructing new levee / dike	681.2	1.54
308	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	2650.8	4.77
309	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	5460.5	3.54
452	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	3976.2	5.23
453	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	2479.6	5.45
454	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	1639.9	4.74
455	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	957.0	4.29
456	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	1156.3	5.05
457	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	2155.9	4.77
458	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	1066.7	4.50

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
10	Mantoloking Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6092.8	1.34
11	Mantoloking Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	12686.2	0.52

OBJECTID	Mun_Name	Existing_Condition	Selected Flood Defense Measures	Length	
22	Pt. Pleasant Beach Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5103.3	1.37
23	Pt. Pleasant Beach Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3497.1	4.29
321	Pt. Pleasant Beach Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	792.7	3.63
463	Pt. Pleasant Beach Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1716.6	1.23

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
1	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1541.9	2.61
2	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	8964.1	1.66
3	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1112.9	0.33
4	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1917.7	1.05
5	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2769.5	1.44
6	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1625.3	1.20
7	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1115.8	1.06
24	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1083.1	2.85
25	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2886.9	1.93
26	Pt. Pleasant Boro.	Salt marsh	Constructing new levee / dike	610.6	3.35
28	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	913.0	1.48
29	Pt. Pleasant Boro.	Dock / shipyard bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	502.7	1.67

30	Pt. Pleasant Boro.	Salt marsh	Constructing new levee / dike	772.2	2.91
31	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	115.0	1.31
32	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	282.5	0.92
33	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	408.2	1.41
34	Pt. Pleasant Boro.	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	109.2	2.33
35	Pt. Pleasant Boro.	Wooded wetland	Constructing new levee / dike	2595.6	1.30
36	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1274.6	1.46
37	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5177.9	1.07
130	Pt. Pleasant Boro.	Bridge	Constructing movable or removable flood panel	1041.4	1.44
131	Pt. Pleasant Boro.	Bridge	Constructing movable or removable flood panel	768.2	1.44
322	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1898.9	1.33
323	Pt. Pleasant Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	460.2	1.57
324	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2146.1	1.84
325	Pt. Pleasant Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1157.8	3.62
326	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	249.3	2.09
327	Pt. Pleasant Boro.	Roadway edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel Raising roadway	1542.5	1.47
328	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	411.3	2.18
329	Pt. Pleasant Boro.	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	285.4	1.72
331	Pt. Pleasant Boro.	Mixed wooded wetland	Constructing new levee / dike Constructing new concrete flood wall with or without movable panel	770.2	1.83
332	Pt. Pleasant Boro.	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	355.4	1.87
333	Pt. Pleasant Boro.	Route 88 edge	Constructing new concrete flood wall	840.4	0.69
438	Pt. Pleasant Boro.	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel	837.5	1.31

			Constructing new concrete flood wall with or without movable panel		
439	Pt. Pleasant Boro.	Bridge	Constructing movable or removable flood panel	122.9	1.54
440	Pt. Pleasant Boro.	Bridge	Constructing movable or removable flood panel	128.8	1.54
441	Pt. Pleasant Boro.	Sand beach bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	523.7	2.14
462	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	514.5	2.48
27	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	802.2	1.37

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
250	Seaside Heights Boro.	sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2749.1	0.41
361	Seaside Heights Boro.	sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1258.1	1.74

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
253	Seaside Park Boro.	Sand/ earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1691.7	1.10
254	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1237.5	2.77
255	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1567.2	2.31
256	Seaside Park Boro.	Vegetated dune	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3833.7	1.52
363	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1937.0	2.04
364	Seaside Park Boro.	Beach earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	309.4	1.91
365	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2864.4	1.65
366	Seaside Park Boro.	Dock inland side	Constructing Concrete flood wall with or without movable panel	2683.5	0.73
367	Seaside Park Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel	1180.8	1.94

			Constructing new concrete flood wall with or without movable panel		
368	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	489.2	1.49
461	Seaside Park Boro.	Sand dune (Ocean side)	Constructing new concrete flood wall (Seawall) with or without movable panel Constructing new with or without rubble or tube core New dune with layer cemented by spraying sand color cement liquid below top sand layer	2107.7	5.81

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
226	South Toms River Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2424.4	0.12

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
259	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4420.6	0.47
260	Stafford TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1540.2	1.31
261	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	8137.3	0.00
262	Stafford TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	241.5	1.79
263	Stafford TWP	Newell Ave edge	Constructing new levee / dike along roadway Raising roadway Newell Ave	6627.2	0.81
265	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	421.6	0.87
266	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	750.5	1.17
267	Stafford TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	499.5	2.62
268	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	803.5	1.64
269	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1148.8	1.58
270	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	879.0	2.13
271	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	602.9	1.04

272	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	659.0	4.76
273	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	738.4	1.76
274	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1864.6	3.80
275	Stafford TWP	Coastal wetland	Constructing new levee / dike	699.1	3.20
276	Stafford TWP	Coastal wetland	Constructing new levee / dike	548.8	3.24
277	Stafford TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	902.6	3.83
278	Stafford TWP	E Bay Ave edge	Constructing new levee / dike Raising roadway	4769.2	4.14
279	Stafford TWP	Hillard Blvd edge	Constructing new levee / dike along the roadway Raising roadway	559.0	0.60
280	Stafford TWP	Hillard Blvd edge	Constructing new levee / dike along roadway Raising roadway	716.3	3.02
281	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1435.1	1.54
282	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1095.6	2.18
283	Stafford TWP	Salt marsh	Constructing new levee / dike	859.8	3.33
284	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	847.5	1.73
285	Stafford TWP	Bridge	Constructing movable or removable flood panel	446.2	0.51
286	Stafford TWP	Bridge	Constructing movable or removable flood panel	440.5	0.51
287	Stafford TWP	Bridge	Constructing movable or removable flood panel	364.1	1.45
288	Stafford TWP	Bridge	Constructing movable or removable flood panel	367.7	1.45
289	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	698.6	1.12
290	Stafford TWP	Salt marsh	Constructing new levee / dike	714.6	2.15
291	Stafford TWP	Bridge	Constructing movable or removable flood panel	455.1	0.38
292	Stafford TWP	Bridge	Constructing movable or removable flood panel	458.9	0.45
293	Stafford TWP	Bridge	Constructing movable or removable flood panel	2417.9	1.13
294	Stafford TWP	Bridge	Constructing movable or removable flood panel	2418.3	1.13
319	Stafford TWP	Roadway edge	Constructing new levee / dike Raising roadway	902.1	1.64
320	Stafford TWP	Roadway edge	Constructing new levee / dike	71.7	0.48

			Raising roadway		
443	Stafford TWP	Sand/earth bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	767.7	2.30
444	Stafford TWP	Recreation land	Constructing new metal sheet bulkhead with or without movable panel Constructing new levee / dike	239.4	2.09
445	Stafford TWP	Salt marsh	Constructing new levee / dike	475.7	3.55
446	Stafford TWP	E Bay Ave edge	Constructing new concrete flood wall with or without removable panel Constructing new concrete flood wall with or without movable panel	299.8	1.99
447	Stafford TWP	Salt marsh bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1294.8	4.37

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
21	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2418.3	0.67
345	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	253.8	2.25
346	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	136.8	2.41
143	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2215.5	1.58
144	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	140.3	2.87
145	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	463.9	3.32
146	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	232.5	2.27
147	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2551.7	0.72
148	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	349.5	2.71
149	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2487.7	1.31
150	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4981.4	1.28

151	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1372.5	0.93
152	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	383.1	0.63
153	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	241.3	0.75
154	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	319.0	1.15
155	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	228.5	0.62
156	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1271.6	0.96
157	Toms River TWP	Salt marsh	Constructing new levee / dike	768.0	2.79
158	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	353.1	1.96
159	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1363.2	1.11
160	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3743.5	0.56
161	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	968.7	0.68
162	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1269.4	1.00
163	Toms River TWP	Sand /earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	263.0	2.04
164	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2657.8	1.19
165	Toms River TWP	Sand /earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	196.4	1.82
166	Toms River TWP	Salt marsh	Constructing new levee / dike	213.3	2.68
167	Toms River TWP	Salt marsh	Constructing new levee / dike	570.4	2.81
168	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	273.2	2.23
169	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	864.2	0.83
170	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2554.1	0.60
171	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	701.4	0.64
172	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	821.1	0.72
173	Toms River TWP	Wooded wetland	Constructing new levee / dike	817.7	1.24
174	Toms River TWP	Wooded wetland	Constructing new levee / dike	252.0	2.94
175	Toms River TWP	Wooded wetland	Constructing new levee / dike	3342.8	1.58
176	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2696.0	2.48
177	Toms River TWP	wooded wetland	Constructing new levee / dike	222.0	2.06

178	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	779.9	1.30
179	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	593.2	1.14
180	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1787.8	1.04
181	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1131.2	1.16
182	Toms River TWP	wooded wetland	Constructing new levee / dike	1466.3	1.34
185	Toms River TWP	wooded wetland	Constructing levee / dike	4153.9	0.00
186	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1768.9	1.62
187	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	301.8	1.99
188	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	86.5	1.49
189	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	563.2	1.84
190	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	307.9	0.71
191	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	825.5	1.25
192	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	549.5	0.54
193	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	432.5	1.11
194	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	91.4	1.64
195	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	718.3	1.35
196	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3029.8	1.25
197	Toms River TWP	Sand/earth bank	Constructing new concrete flood wall with or without removable panel Constructing new concrete flood wall with or without movable panel	643.7	1.55
198	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	235.3	1.81
199	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4409.5	1.45
200	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	559.5	2.02
201	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1235.3	1.12
202	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	278.1	0.54
203	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	672.2	1.60
204	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	123.9	0.98
205	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	663.8	1.46

206	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2394.4	1.15
207	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	406.5	1.34
208	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1892.8	1.06
215	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2000.3	0.97
216	Toms River TWP	Wooded wetland	Constructing new levee / dike	622.6	0.94
217	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3128.1	0.74
218	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1341.6	1.20
219	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1370.5	2.05
220	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2228.2	1.06
221	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1210.6	0.91
222	Toms River TWP	Dock / shipyard	Constructing movable or removal flood panel	841.7	1.26
223	Toms River TWP	E Water St edge	Constructing new concrete flood wall with or without removable panel	117.0	1.35
224	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	943.8	1.91
225	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	174.7	1.60
227	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without removable panel	236.9	2.68
228	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	304.9	1.43
229	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1083.3	2.10
230	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2280.1	1.06
231	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	491.8	1.96
232	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	614.7	1.39
233	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1836.5	1.09
234	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2893.2	1.77
235	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1178.1	1.67
236	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	227.8	1.57
237	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	127.9	2.20
238	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1877.7	1.09
239	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	378.3	1.97

240	Toms River TWP	Salt marsh	Constructing new concrete flood wall with or without removable panel Constructing new metal sheet bulkhead with or without movable panel	584.6	1.28
241	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	363.2	1.54
245	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1486.6	0.71
246	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3918.5	0.85
247	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	950.0	1.09
248	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	378.4	1.80
249	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	611.4	1.55
251	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1001.1	1.58
313	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	889.1	1.41
315	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	322.2	0.67
347	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	867.2	1.75
348	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	240.7	2.29
349	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	200.3	1.78
350	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	90.7	1.66
351	Toms River TWP	Bulkhead	Constructing new metal sheet bulkhead with or without movable panel	412.3	1.13
352	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel	232.6	1.73
353	Toms River TWP	Earth bank	Constructing new concrete flood wall with or without removable panel Constructing new metal sheet bulkhead with or without movable panel	221.5	1.86
354	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	272.2	1.52
355	Toms River TWP	Sand / earth bank	Constructing new concrete flood wall with or without removable panel Constructing new metal sheet bulkhead with or without movable panel	268.1	2.17
359	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	422.7	1.66
360	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	676.9	0.82
370	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel	876.4	2.29

			Constructing new metal sheet bulkhead with or without movable panel		
371	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	503.8	1.54
372	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	1384.5	0.00
373	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	1201.1	0.00
374	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	1719.9	1.99
376	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	1276.6	1.93
377	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	201.1	0.66
378	Toms River TWP	sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	485.3	1.18
379	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	460.1	1.12
380	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	858.4	0.25
381	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	488.7	0.87
382	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	344.8	1.01
383	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	269.9	1.75
384	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	149.7	1.26
385	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	173.0	1.60
386	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	539.5	1.64
387	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	378.2	2.43
388	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel	652.0	2.45

			Constructing new metal sheet bulkhead with or without movable panel		
389	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5738.2	0.55
390	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	222.6	1.58
391	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	802.8	1.72
392	Toms River TWP	Sand/ Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	568.4	2.00
393	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1349.0	1.26

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
303	Tuckerton Boro	Salt marsh	Constructing new levee / dike	1701.6	2.18
304	Tuckerton Boro.	Deciduous / shrubland	Constructing new levee / dike	646.0	1.44
305	Tuckerton Boro.	Salt march	Constructing new levee / dike	11385.5	3.33
306	Tuckerton Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1156.0	2.68
310	Tuckerton Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1182.9	2.54
311	Tuckerton Boro.	Salt marsh	Constructing new levee / dike	1516.4	3.10
312	Tuckerton Boro.	Wooded wetland	Constructing new levee / dike over upland	2551.0	1.56
448	Tuckerton Boro.	Salt marsh	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	1039.8	3.58
449	Tuckerton Boro.	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	864.6	2.75
450	Tuckerton Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1103.0	3.22
451	Tuckerton Boro.	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new metal sheet bulkhead with or without movable panel	475.9	3.29

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OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
8	Bay Head Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1178.4	4.72
9	Bay Head Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4095.7	4.13

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
254	Berkeley TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3613.4	3.16
259	Berkeley TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing concrete flood wall with or without movable panel	1451.4	3.19
260	Berkeley TWP	Salt mash	Constructing new levee / dike Constructing concrete flood wall with or without movable panel	2212.6	4.17
318	Berkeley TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1103.3	2.47
320	Berkeley TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing concrete flood wall with or without movable panel	958.3	2.55
321	Berkeley TWP	Pond bank beside bay	Constructing new metal sheet bulkhead with or without movable panel Constructing concrete flood wall with or without movable panel	1373.8	2.00
366	Berkeley TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	410.5	1.84
373	Berkeley TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1248.6	2.48

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
12	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2129.9	2.97
13	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	991.5	2.47
14	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1699.9	1.37
15	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3486.7	0.91
16	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	559.5	2.29
17	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	571.6	2.39
18	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	748.8	2.65
19	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1918.9	2.89
20	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	640.1	4.19
38	Brick TWP	Jordan Rd edge	Raising roadway Constructing new levee /dike	5702.7	2.10
39	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6158.0	2.49
40	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4314.9	3.81
41	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1381.1	2.86
42	Brick TWP	Vegetated stream bank	Constructing new levee / dike along the stream bank	5096.5	2.98
43	Brick TWP	Roadway edge above culvert	Constructing new concrete flood wall above the culvert	125.0	0.95
44	Brick TWP	Mixed wooded wetland	Constructing new levee / dike	796.7	1.98
45	Brick TWP	Salt marsh	Constructing new levee / dike	1311.9	3.29
46	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	595.4	4.10
47	Brick TWP	Mixed wooded wetland	Constructing new levee / dike	1077.8	2.93
48	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1036.1	3.64
49	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel	3152.5	3.86

			Constructing new concrete flood wall with or without movable panel		
50	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	835.5	4.03
51	Brick TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3564.6	2.88
52	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	937.3	2.39
53	Brick TWP	Sand bank	Constructing new metal sheet bulkhead with or without movable panel	3778.9	3.12
54	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3335.5	2.55
55	Brick TWP	Deciduous brush bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	587.2	3.47
56	Brick TWP	bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1528.7	2.47
57	Brick TWP	Sand bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	797.8	4.20
58	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1443.0	3.95
59	Brick TWP	Mixed forest	Constructing new levee / dike	136.3	0.90
60	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	6029.0	4.46
61	Brick TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	526.7	3.05
62	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	2520.1	3.79
63	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1450.0	3.64
64	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1434.4	3.61
65	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1145.8	2.48
66	Brick TWP	Mixed wood wetland	Constructing new levee / dike	515.8	2.58
67	Brick TWP	Mixed wood wetland	Constructing new levee / dike	2184.3	2.07
68	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	537.8	3.29
69	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5703.3	2.69
70	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3292.1	3.42
72	Brick TWP	Salt marsh	Constructing new levee / dike	654.2	3.13

73	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	383.9	2.49
74	Brick TWP	Sand beach bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2576.8	4.18
75	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3819.3	2.51
76	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1899.8	3.25
77	Brick TWP	Sand bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	323.6	4.39
78	Brick TWP	Shrub wetlands	Constructing new levee / dike	1538.1	3.31
79	Brick TWP	Shrub wetlands	Constructing new levee / dike	3913.7	3.24
80	Brick TWP	Shrub wetlands	Constructing new levee / dike	1671.2	3.69
81	Brick TWP	Shrub wetlands	Constructing new levee / dike	6040.0	2.99
82	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	2757.0	3.95
83	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1417.7	3.69
84	Brick TWP	Salt marsh	Constructing new levee / dike	779.0	3.97
85	Brick TWP	Roadway edge	Constructing new levee / dike Constructing new concrete flood wall with or without movable panel	760.1	2.95
86	Brick TWP	Wooded wetland	Constructing new levee / dike Raising residence (1 unit)	278.6	2.80
87	Brick TWP	Roadway edge	Constructing new levee / dike Raising roadway	977.5	3.87
88	Brick TWP	Roadway edge	Constructing new levee / dike Raising roadway	819.9	3.16
89	Brick TWP	Wooded wetland	Constructing new levee / dike Raising residences (4 units)	557.1	3.57
90	Brick TWP	Wooded wetland	Constructing new levee / dike	3954.2	3.46
91	Brick TWP	Mantoloking Rd edge	Constructing new concrete flood wall with or without removable panel	241.9	2.92
92	Brick TWP	Wooded wetland	Constructing new levee / dike	2315.4	2.81
93	Brick TWP	Roadway	Constructing new levee / dike Raising roadway	1723.2	2.39

94	Brick TWP	Wooded wetland	Constructing new levee / dike	285.5	0.00
95	Brick TWP	Wooded wetland	Constructing new levee / dike	304.8	0.59
98	Brick TWP	Wooded wetland	Constructing new levee / dike	5814.1	4.16
99	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1116.0	3.47
100	Brick TWP	Roadway edge	Raising roadway Constructing new levee / dike	4213.9	3.46
101	Brick TWP	Roadway edge	Raising roadway Constructing new levee / dike	3552.8	3.91
102	Brick TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1642.4	2.61
103	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1726.5	3.57
104	Brick TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	432.8	4.74
105	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	991.0	4.46
106	Brick TWP	Coniferous forest	Constructing new levee / dike	3953.9	1.79
107	Brick TWP	Coniferous forest	Constructing new levee / dike	560.1	0.65
108	Brick TWP	Coniferous forest	Constructing new levee / dike	467.8	0.00
109	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3284.3	2.63
110	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2380.4	4.22
111	Brick TWP	Coniferous forest	Constructing new levee / dike	2454.5	2.07
112	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1634.0	2.72
113	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2764.4	3.16
114	Brick TWP	Coniferous forest	Constructing new levee / dike	4962.1	2.34
115	Brick TWP	Coniferous forest	Constructing new levee / dike	2827.0	1.30
116	Brick TWP	Coniferous forest	Constructing new levee / dike	5534.0	2.75
117	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1838.6	3.49
118	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	281.3	3.31

119	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	275.1	3.42
120	Brick TWP	Coniferous forest	Constructing metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1707.6	1.71
121	Brick TWP	Roadway edge	Constructing new concrete flood wall with or without removable panel Constructing new concrete flood wall with or without movable panel	357.5	1.63
123	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3228.8	2.47
124	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1128.6	4.26
125	Brick TWP	Salt marsh	Constructing new levee / dike	3577.5	4.08
126	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1307.2	2.22
127	Brick TWP	Roadway edge	Raising roadway Constructing new levee / dike	3061.3	3.97
128	Brick TWP	Roadway edge	Raising roadway Constructing new levee / dike	3759.6	3.41
129	Brick TWP	Salt marsh	Constructing new levee / dike	137.4	4.61
130	Brick TWP	Roadway along bay	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	723.9	3.95
131	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	696.2	2.79
134	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2444.7	4.32
135	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	2514.0	3.95
136	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1845.2	3.57
137	Brick TWP	Herbertsville Rd edge	Constructing new concrete flood wall above culvert	260.5	1.52
138	Brick TWP	Wooded wetland	Constructing new levee / dike	578.3	0.98
139	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1967.9	4.32
140	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	412.0	1.55

			Raising residences (2 units)		
141	Brick TWP	Mixed wooded wetland	Constructing new levee / dike Raising residence (1 unit)	301.5	2.01
142	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1696.1	3.22
143	Brick TWP	Beverly Beach Rd edge	Constructing new concrete flood wall along shoulder	684.9	0.84
144	Brick TWP	Beverly Beach Rd edge	Constructing new concrete flood wall along shoulder	560.7	0.82
334	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	462.4	3.83
338	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3043.5	3.20
339	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	937.7	4.07
340	Brick TWP	Wooded wetland	Constructing new levee / dike	2251.4	2.52
341	Brick TWP	Midstreams Rd edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	931.0	2.57
342	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	924.6	2.58
343	Brick TWP	Bay bank	Constructing new metal sheet with or without movable panel Constructing new concrete flood wall with or without movable panel	521.7	2.01
344	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	307.4	3.22
345	Brick TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	201.7	3.29
346	Brick TWP	Bulkhead	Increasing bulkhead height with or without movable panel	1165.5	2.90
347	Brick TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	580.7	3.60
348	Brick TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	259.3	3.24
398	Brick TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	574.3	2.42
399	Brick TWP	Bulkhead	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	976.6	3.47

400	Brick TWP	Sand bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	442.7	3.66
401	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	537.5	3.72
402	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	587.2	1.44
403	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1320.3	2.17
404	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1727.7	3.46
405	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	593.2	2.94
406	Brick TWP	Coniferous forest	Constructing new levee / dike	86.7	3.09
407	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	555.3	3.39
408	Brick TWP	Coniferous forest	Constructing new levee / dike	1645.6	2.92
409	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2238.5	3.23
410	Brick TWP	Coniferous forest	Constructing new levee / dike	2092.0	2.87
411	Brick TWP	Coniferous forest	Constructing new levee / dike	897.9	1.54
412	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	969.6	3.18
413	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	991.6	2.06
414	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	606.3	4.14
415	Brick TWP	Roadway edge	Constructing new levee / dike	762.8	3.64
416	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	480.8	2.65
417	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	821.1	2.33
418	Brick TWP	Salt marsh	Constructing new levee / dike	863.7	4.98
419	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1398.8	3.14
420	Brick TWP	Salt marsh	Constructing new levee / dike	751.7	3.52
421	Brick TWP	Shrub wetland	Constructing new levee / dike	1021.9	3.77
422	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2637.2	3.46

423	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1524.4	3.21
424	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1351.5	3.80
425	Brick TWP	Salt marsh	Constructing new levee / dike	501.1	2.49
426	Brick TWP	Salt marsh	Constructing new levee / dike	967.5	1.81
427	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1070.6	4.63
428	Brick TWP	Roadway edge	Constructing new levee / dike	766.0	3.28
429	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	703.6	3.85
430	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1329.2	4.02
431	Brick TWP	sand beach bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	737.8	4.41
432	Brick TWP	Bridge	Constructing movable or removable flood panel	193.8	3.83
433	Brick TWP	Bridge	Constructing movable or removable flood panel	205.8	3.16
434	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1014.4	3.58
435	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead t with or without movable panel Constructing new concrete flood wall with or without movable panel	247.0	3.58
436	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2856.3	3.66
437	Brick TWP	Bridge	Constructing movable flood panel	135.1	1.25
438	Brick TWP	Bridge	Constructing movable flood panel	117.5	1.25
439	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	902.1	4.25
440	Brick TWP	Midstreams Rd edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	277.3	0.91
441	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	421.6	4.21
446	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1353.1	4.74
463	Brick TWP	Wooded wetlands	Constructing new levee / dike Raising the residences (3 units)	758.6	0.50

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
322	Eagleswood TWP	Upland rights-of-way undeveloped	Constructing new levee / dike over upland	4220.2	3.65

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
211	Island Heights Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2118.2	2.83
212	Island Heights Boro.	Dock/shipyard	Constructing movable or removable flood panel	1191.5	2.93
213	Island Heights Boro.	Dock/shipyard	Constructing movable or removable flood panel	463.3	2.45
214	Island Heights Boro.	Dock/shipyard	Constructing movable or removable flood panel	510.5	1.92
215	Island Heights Boro.	Dock/shipyard	Constructing movable or removable flood panel	521.5	2.01
216	Island Heights Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3930.2	2.98
379	Island Heights Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	465.3	3.00

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
244	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	582.7	3.73
245	Lavallette Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3828.6	3.04
246	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6026.3	1.98
360	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1285.8	3.5
361	Lavallette Boro.	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel	617.1	3.99

			Constructing new concrete flood wall with or without movable panel		
362	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	227.3	3.75

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
297	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	9974.4	5.10
298	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	4502.0	7.15
299	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	1598.2	6.62
300	Little Egg Harbor TWP	Salt marsh	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1554.5	4.71
301	Little Egg Harbor TWP	Salt marsh	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1987.1	5.99
302	Little Egg Harbor TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1017.1	5.33
303	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike alone roadway	2562.3	6.25
304	Little Egg Harbor TWP	Shrub wetland	Constructing new levee / dike	2998.1	2.82
309	Little Egg Harbor TWP	Wooded wetland	Constructing new levee / dike	681.2	2.46
310	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	2650.8	6.25
311	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	5460.5	6.01
456	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	3977.9	7.25
457	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	2479.9	7.80
458	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	1641.0	6.92
459	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	924.7	6.38
460	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	1158.1	6.92
461	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	2116.0	6.89
462	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	1059.2	6.78

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
10	Mantoloking Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6092.8	3.81
11	Mantoloking Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	12686.2	3.02

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
22	Pt. Pleasant Beach Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5103.3	4.96
23	Pt. Pleasant Beach Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2622.7	5.36
325	Pt. Pleasant Beach Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	792.7	4.79
467	Pt. Pleasant Beach Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1716.6	2.27

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
1	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1541.9	4.92
2	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	8964.1	2.98
3	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1112.9	3.23
4	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1917.7	3.66
5	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2769.5	3.68
6	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1625.3	3.08
7	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1115.8	3.70
24	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1083.1	4.38
25	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2886.9	3.07

26	Pt. Pleasant Boro.	Salt marsh	Constructing new levee / dike	610.6	5.46
28	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	913.0	4.15
29	Pt. Pleasant Boro.	Dock / shipyard bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	502.7	4.09
30	Pt. Pleasant Boro.	Salt marsh	Constructing new levee / dike	772.2	5.41
31	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	115.0	3.83
32	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	282.5	2.87
33	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	408.2	3.50
34	Pt. Pleasant Boro.	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	109.2	4.88
35	Pt. Pleasant Boro.	Wooded wetland	Constructing new levee / dike	2595.6	3.37
36	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1274.6	3.67
37	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5177.9	2.66
132	Pt. Pleasant Boro.	Bridge	Constructing movable or removable flood panel	1041.4	0.44
133	Pt. Pleasant Boro.	Bridge	Constructing movable or removable flood panel	768.2	0.55
326	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1898.9	3.07
327	Pt. Pleasant Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	460.2	4.65
328	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2146.1	2.39
329	Pt. Pleasant Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1157.8	3.56
330	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	249.3	5.43
331	Pt. Pleasant Boro.	Roadway edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel Raising roadway	1542.5	2.51
332	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	411.3	4.64
333	Pt. Pleasant Boro.	Salt marsh	Constructing new metal sheet bulkhead with or without movable panel	285.4	2.82

			Constructing new concrete flood wall with or without movable panel		
335	Pt. Pleasant Boro.	Mixed wooded wetland	Constructing new levee / dike Constructing new concrete flood wall with or without movable panel	770.2	2.86
336	Pt. Pleasant Boro.	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	355.4	4.41
337	Pt. Pleasant Boro.	Route 88 edge	Constructing new concrete flood wall with or without movable panel	840.4	1.20
442	Pt. Pleasant Boro.	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	837.5	3.74
443	Pt. Pleasant Boro.	Bridge	Constructing movable or removable flood panel	122.9	0.14
444	Pt. Pleasant Boro.	Bridge	Constructing movable or removable flood panel	128.8	0.24
445	Pt. Pleasant Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	523.7	4.07
466	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	514.5	4.42
27	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	802.2	3.99

OBJECTID	**Mun. Name**	**Existing Condition**	**Selected Flood Defense Measures**	**Length**	**Ave. Water Depth**
252	Seaside Heights Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2749.1	1.47
365	Seaside Heights Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1258.1	3.91
464	Seaside Heights Boro.	Sand dune (Ocean side)	Constructing new concrete flood wall (seawall) with or without movable panel Constructing new dune with or without rubble or tube core	4182.9	6.09
			New dune with layer cemented by spraying sand color cement liquid below top sand layer		

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
255	Seaside Park Boro.	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1691.7	3.13
256	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1237.5	3.39
257	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1567.2	4.52
258	Seaside Park Boro.	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3833.7	3.49
367	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1937.0	2.68
368	Seaside Park Boro.	Beach earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	309.4	3.94
369	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2864.4	4.13
370	Seaside Park Boro.	Dock inland side	Constructing Concrete flood wall with or without removable panel	2683.5	2.76
371	Seaside Park Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1180.8	4.01
372	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	489.2	3.50
465	Seaside Park Boro.	Sand dune (Ocean side)	Constructing new concrete flood wall (seawall) with or without movable panel Constructing new with or without rubble or tube core New dune with layer cemented by spraying sand color cement liquid below top sand layer	2107.7	8.16

OBJECTID *	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
228	South Toms River Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2424.4	1.36

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
261	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4420.6	0.95
262	Stafford TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1540.2	0.75
263	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	8137.3	1.50
264	Stafford TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable wall	241.5	5.27
265	Stafford TWP	Newell Ave edge	Constructing new levee / dike along roadway Raising roadway Newell Ave	8471.3	3.65
266	Stafford TWP	Herbaceous wetland	Constructing new levee / dike	445.0	2.69
267	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	421.6	1.83
268	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	750.5	2.65
269	Stafford TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	499.5	3.09
270	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	803.5	2.74
271	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1148.8	2.97
272	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	879.0	2.85
273	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	602.9	1.64
274	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	659.0	5.20
275	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	738.4	4.17
276	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1864.6	4.98
277	Stafford TWP	Coastal wetland	Constructing new levee / dike	699.1	4.50
278	Stafford TWP	Coastal wetland	Constructing new levee / dike	548.8	5.09
279	Stafford TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	902.6	4.76
280	Stafford TWP	E Bay Ave edge	Constructing new levee / dike	4769.2	5.95

			Raising roadway		
281	Stafford TWP	Hillard Blvd edge	Constructing new levee / dike along the roadway Raising roadway	2196.5	1.79
282	Stafford TWP	Hillard Blvd edge	Constructing new levee / dike along roadway Raising roadway	716.3	4.45
283	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1435.1	3.86
284	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1095.6	3.70
285	Stafford TWP	Salt marsh	Constructing new levee / dike	859.8	5.12
286	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	847.5	3.36
287	Stafford TWP	Bridge	Constructing movable or removable flood panel	446.2	1.07
288	Stafford TWP	Bridge	Constructing movable or removable flood panel	440.5	0.73
289	Stafford TWP	Bridge	Constructing movable or removable flood panel	364.1	1.57
290	Stafford TWP	Bridge	Constructing movable or removable flood panel	367.7	0.80
291	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	698.6	2.54
292	Stafford TWP	Salt marsh	Constructing new levee / dike	714.6	4.03
293	Stafford TWP	Bridge	Constructing movable flood panel	455.1	0.69
294	Stafford TWP	Bridge	Constructing movable flood panel	458.9	0.76
295	Stafford TWP	Bridge	Constructing movable flood panel	2417.9	0.91
296	Stafford TWP	Bridge	Constructing movable flood panel	2418.3	0.91
323	Stafford TWP	Roadway edge	Constructing new levee / dike Raising roadway	902.1	3.30
324	Stafford TWP	Roadway edge	Constructing new levee / dike Raising roadway	71.7	1.73
447	Stafford TWP	Sand/earth bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	767.7	3.60
448	Stafford TWP	Recreation land	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	239.4	3.04
449	Stafford TWP	Salt marsh	Constructing new levee / dike	475.7	4.16
450	Stafford TWP	E Bay Ave edge	Constructing new metal sheet bulkhead with or without movable panel	299.8	2.26

			Constructing new concrete flood wall with or without movable panel		
451	Stafford TWP	Salt marsh bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1294.8	5.16

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
21	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2418.3	2.42
349	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	253.8	4.53
350	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	136.8	4.41
122	Toms River TWP	Roadway edge	Constructing new concrete flood wall with or without movable panel	174.5	0.00
145	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2215.5	4.17
146	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	140.3	4.90
147	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	463.9	3.86
148	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	232.5	4.06
149	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2551.7	2.80
150	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	349.5	4.91
151	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2487.7	3.56
152	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4981.4	2.97
153	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1372.5	3.06
154	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	383.1	2.69

155	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	241.3	3.00
156	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	319.0	3.15
157	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	228.5	2.96
158	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1271.6	3.11
159	Toms River TWP	Salt marsh bank	Constructing new levee / dike	768.0	5.62
160	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	353.1	3.51
161	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1363.2	2.81
162	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3743.5	2.27
163	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	968.7	2.30
164	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1269.4	3.02
165	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	263.0	4.25
166	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2657.8	3.02
167	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	196.4	4.14
168	Toms River TWP	Salt Marsh	Constructing new levee / dike	213.3	5.38
169	Toms River TWP	Salt Marsh	Constructing new levee / dike	570.4	4.81
170	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	273.2	4.95
171	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	864.2	2.77
172	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2554.1	3.60
173	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	701.4	2.52
174	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	821.1	2.89
175	Toms River TWP	Wooded wetland	Constructing new levee / dike	817.7	3.19
176	Toms River TWP	Wooded wetland	Constructing new levee / dike	252.0	3.43
177	Toms River TWP	Wooded wetland	Constructing new levee / dike	3342.8	3.93

178	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2696.0	4.12
179	Toms River TWP	Wooded wetland	Constructing new levee / dike	222.0	5.28
180	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	779.9	2.88
181	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	593.2	2.82
182	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1787.8	3.20
183	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1131.2	3.53
184	Toms River TWP	Wooded wetland	Constructing new vegetated levee / dike	1466.3	3.30
185	Toms River TWP	Wooded wetland	Constructing new vegetated levee / dike	3448.6	2.59
186	Toms River TWP	Wooded wetland	Constructing new vegetated levee / dike	2848.5	1.63
187	Toms River TWP	Wooded wetland	Constructing new vegetated levee / dike	5323.6	2.34
188	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1768.9	3.09
189	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	301.8	4.51
190	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	86.5	2.65
191	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	563.2	2.87
192	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	307.9	2.92
193	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	825.5	2.75
194	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	549.5	2.63
195	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	432.5	2.71
196	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	91.4	4.47
197	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	718.3	4.38
198	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3029.8	3.40
199	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	643.7	3.81

200	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	235.3	3.76
201	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4409.5	1.44
202	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	559.5	2.15
203	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1235.3	2.41
204	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	278.1	2.73
205	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	672.2	3.14
206	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	123.9	3.02
207	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	663.8	2.99
208	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2394.4	2.76
209	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	406.5	3.60
210	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1892.8	2.46
217	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2000.3	1.94
218	Toms River TWP	Wooded wetland	Constructing new levee / dike	622.6	2.33
219	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3128.1	1.92
220	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1341.6	2.49
221	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1370.5	4.10
222	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2228.2	2.69
223	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1210.6	2.11
224	Toms River TWP	Dock / shipyard	Constructing concrete flood wall with or without removal panel Constructing movable or removable flood panel	841.7	3.04
225	Toms River TWP	E Water St edge	Constructing new concrete flood wall with or without removable panel	117.0	1.87
226	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	943.8	2.94

227	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	174.7	3.77
229	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	236.9	4.70
230	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	304.9	3.32
231	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1083.3	2.22
232	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2280.1	2.31
233	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	491.8	2.43
234	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	614.7	3.64
235	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1836.5	2.91
236	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2893.2	2.17
237	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1178.1	3.75
238	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	227.8	3.87
239	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	127.9	4.93
240	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1877.7	2.74
241	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	378.3	4.29
242	Toms River TWP	Sand / earth bank	Constructing new concrete flood wall with or without removable panel Constructing new metal sheet bulkhead with or without movable panel	584.6	3.92
243	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	363.2	2.16
247	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1486.6	1.91
248	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3918.5	3.06
249	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	950.0	3.38
250	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	378.4	3.57
251	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	611.4	3.57
253	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1001.1	3.28

317	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	889.1	3.47
319	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	322.2	2.62
351	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	867.2	3.55
352	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	240.7	5.18
353	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	200.3	2.84
354	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	90.7	4.09
355	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	412.3	3.12
356	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	232.6	3.68
357	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	221.5	2.97
358	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	272.2	3.24
359	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	268.1	4.55
363	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	422.7	2.45
364	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	676.9	2.69
374	Toms River TWP	Sand / earth bank	Constructing new bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	876.4	3.06
375	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	503.8	1.79
376	Toms River TWP	Route 37 edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1384.5	1.16
377	Toms River TWP	Route 37 edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1201.1	0.83

378	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1719.9	2.76
380	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1276.6	3.23
381	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	201.1	2.33
382	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	485.3	3.09
383	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	460.1	2.63
384	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	858.4	3.17
385	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	488.7	3.08
386	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	344.8	4.08
387	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	269.9	3.92
388	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	149.7	3.53
389	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	173.0	3.24
390	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	539.5	3.94
391	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	378.2	4.79
392	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	652.0	3.45
393	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5738.2	2.58
394	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	222.6	4.36
395	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	802.8	3.89

396	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	568.4	4.38
397	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1349.0	3.19

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
305	Tuckerton Boro.	Salt marsh	Constructing new levee / dike	1701.6	3.10
306	Tuckerton Boro.	Deciduous / shrubland	Constructing new levee / dike	646.0	3.21
307	Tuckerton Boro.	Salt march	Constructing new levee / dike	11337.2	5.55
308	Tuckerton Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1156.0	4.69
312	Tuckerton Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1182.9	4.61
313	Tuckerton Boro.	Salt marsh	Constructing new levee / dike	1516.4	6.05
316	Tuckerton Boro.	Wooded wetland	Constructing new levee / dike over upland	2551.0	2.01
452	Tuckerton Boro.	Salt marsh	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1039.8	4.84
453	Tuckerton Boro.	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	864.6	3.90
454	Tuckerton Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1103.0	4.99
455	Tuckerton Boro.	Earth bank	Constructing new metal sheet bulkhead with or without movable panel	475.9	4.87
			Constructing new concrete flood wall with or without movable panel		

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OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
9	Bay Head Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1178.4	6.04
10	Bay Head Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4095.7	5.20

OBJECTID *	Mun_Name	Existing_Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
257	Berkeley TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3613.4	4.43
262	Berkeley TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1451.4	4.60
263	Berkeley TWP	Salt marsh	Constructing new levee / dike	2212.6	5.05
321	Berkeley TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1103.3	2.83
323	Berkeley TWP	Beach earth bank	Constructing new levee / dike	958.3	2.59
324	Berkeley TWP	Pond bank beside bay	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1373.8	2.32
369	Berkeley TWP	Bulkhead	Increasing bulkhead height with or without movable panel	410.5	3.63
376	Berkeley TWP	Bulkhead	Increasing bulkhead height with or without movable panel	1248.6	3.44

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
13	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2129.9	3.40
14	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	991.5	4.23

15	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1699.9	2.45
16	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3486.7	1.55
17	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	559.5	3.65
18	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	571.6	3.90
19	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	748.8	3.52
20	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1918.9	3.74
21	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	640.1	4.59
39	Brick TWP	Jordan Rd edge	Raising roadway Constructing new levee /dike	5702.7	3.70
40	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6158.0	3.31
41	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4314.9	4.83
42	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1381.1	3.36
43	Brick TWP	Vegetated stream bank	Constructing new levee / dike along the stream bank	5096.5	4.60
44	Brick TWP	Roadway edge above culvert	Constructing new concrete flood wall above the culvert inlet	162.7	2.02
45	Brick TWP	Mixed wooded wetland	Constructing new levee / dike	986.3	2.73
46	Brick TWP	Salt marsh	Constructing new levee / dike	1311.9	3.44
47	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	595.4	4.94
48	Brick TWP	Mixed wooded wetland	Constructing new levee / dike	1077.8	3.49
49	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1036.1	4.62
50	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3152.5	5.64
51	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	835.5	4.94
52	Brick TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3564.6	3.16
53	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	937.3	3.71
54	Brick TWP	Sand bank	Constructing new metal sheet bulkhead with or without movable panel	3778.9	3.91

			Constructing new concrete flood wall with or without movable panel		
55	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3335.5	3.90
56	Brick TWP	Deciduous brush bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	587.2	5.26
57	Brick TWP	bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1528.7	3.68
58	Brick TWP	Sand bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	797.8	5.37
59	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1443.0	4.99
60	Brick TWP	Mixed forest	Constructing new levee / dike	136.3	1.27
61	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	6029.0	5.39
62	Brick TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	526.7	5.21
63	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	2520.1	4.60
64	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1450.0	4.99
65	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1434.4	3.64
66	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1145.8	3.23
67	Brick TWP	Mixed wood wetland	Constructing new levee / dike	515.8	3.77
68	Brick TWP	Mixed wood wetland	Constructing new levee / dike	2184.3	2.90
69	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	537.8	4.92
70	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5703.3	3.66
71	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3292.1	4.52
72	Brick TWP	Mixed wood wetland	Constructing new levee / dike	689.3	2.38
73	Brick TWP	Salt marsh	Constructing new levee / dike	420.8	3.19
74	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	383.9	3.22
75	Brick TWP	Sand beach bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2576.8	4.44
76	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3819.3	4.84

77	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1899.8	4.04
78	Brick TWP	Sand bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	323.6	5.53
79	Brick TWP	Shrub wetlands	Constructing new levee / dike	1538.1	4.64
80	Brick TWP	Shrub wetlands	Constructing new levee / dike	3913.7	6.15
81	Brick TWP	Shrub wetlands	Constructing new levee / dike	1671.2	5.58
82	Brick TWP	Shrub wetlands	Constructing new levee / dike	6040.0	4.23
83	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	2757.0	5.35
84	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1417.7	4.71
85	Brick TWP	Salt wetland	Constructing new levee / dike	779.0	5.21
86	Brick TWP	Roadway edge	Constructing new levee / dike Constructing new concrete flood wall with or without movable panel	760.1	3.84
87	Brick TWP	Wooded wetland	Constructing new levee / dike Raising residence (1 unit)	278.6	3.48
88	Brick TWP	Roadway edge	Constructing new levee / dike Raising roadway	977.5	5.18
89	Brick TWP	Roadway edge	Constructing new levee / dike Raising roadway	819.9	4.52
90	Brick TWP	Wooded wetland	Constructing new levee / dike Raising residence (4 units)	557.1	4.32
91	Brick TWP	Wooded wetland	Constructing new levee / dike	3954.2	4.04
92	Brick TWP	Mantoloking Rd edge	Constructing new concrete flood wall with or without removable panel	241.9	4.07
93	Brick TWP	Wooded wetland	Constructing new levee / dike	2315.4	3.72
94	Brick TWP	Roadway	Constructing new levee / dike Raising roadway	1723.2	3.39
95	Brick TWP	Wooded wetland	Constructing new levee / dike	285.5	0.26
96	Brick TWP	Wooded wetland	Constructing new levee / dike	681.8	0.89
97	Brick TWP	Wooded wetland	Constructing new levee / dike	96.2	0.13
99	Brick TWP	Wooded wetland	Constructing new levee / dike	1300.2	0.30

100	Brick TWP	Salt marsh	Constructing new levee / dike	5814.1	4.12
101	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1116.0	4.79
102	Brick TWP	Roadway edge	Raising roadway Constructing new levee / dike	4213.9	4.67
103	Brick TWP	Roadway edge	Raising roadway Constructing new levee / dike	3552.8	5.23
104	Brick TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1642.4	4.05
105	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1726.5	4.51
106	Brick TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	432.8	5.92
107	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	991.0	5.66
108	Brick TWP	Coniferous forest	Constructing new levee / dike	3953.9	2.38
109	Brick TWP	Coniferous forest	Constructing new levee / dike	792.2	1.55
110	Brick TWP	Coniferous forest	Constructing new levee / dike	467.8	0.45
111	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3284.3	3.71
112	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2380.4	4.24
113	Brick TWP	Coniferous forest	Constructing new levee / dike	2454.5	2.59
115	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1634.0	3.97
116	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2764.4	4.64
117	Brick TWP	Coniferous forest	Constructing new levee / dike	4962.1	3.85
118	Brick TWP	Coniferous forest	Constructing new levee / dike	2827.0	2.84
119	Brick TWP	Coniferous forest	Constructing new levee / dike	5534.0	4.20
120	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1838.6	4.29
121	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	281.3	3.53
122	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	275.1	4.10
123	Brick TWP	Coniferous forest	Constructing new metal sheet bulkhead with or without movable panel	1707.6	2.62

			Constructing new concrete flood wall with or without movable panel		
124	Brick TWP	Roadway edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	541.1	2.14
126	Brick TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3228.8	3.51
127	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1128.6	5.64
128	Brick TWP	Salt marsh	Constructing new levee / dike	3577.5	5.60
129	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1307.2	3.26
130	Brick TWP	Roadway edge	Raising roadway Constructing new levee / dike	3061.3	5.01
131	Brick TWP	Roadway edge	Raising roadway Constructing new levee / dike	3759.6	5.31
132	Brick TWP	Salt marsh	Constructing new levee / dike	137.4	5.50
133	Brick TWP	Roadway along bay	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	723.9	5.27
134	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	696.2	3.17
137	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2444.7	5.39
138	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	2514.0	4.04
139	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1845.2	3.72
140	Brick TWP	Herbertsville Rd edge	Constructing new concrete flood wall above culvert	260.5	2.17
141	Brick TWP	Wooded wetland	Constructing new levee / dike	578.3	0.93
142	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1967.9	4.75
143	Brick TWP	Vegetated earth bank	Constructing new concrete flood wall with or without removable panel Constructing new concrete flood wall with or without movable panel	412.0	3.10
144	Brick TWP	Mixed wooded wetland	Constructing new levee / dike Raising residence (1 units)	301.5	3.97

145	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1696.1	3.03
146	Brick TWP	Beverly Beach Rd edge	Constructing new concrete flood wall along shoulder	684.9	1.53
147	Brick TWP	Beverly Beach Rd edge	Constructing new concrete flood wall along shoulder	560.7	1.01
337	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	462.4	4.55
341	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3043.5	3.83
342	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	937.7	5.47
343	Brick TWP	Wooded wetland	Constructing new levee / dike	2251.4	2.91
344	Brick TWP	Midstreams Rd edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	931.0	2.49
345	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	924.6	3.41
346	Brick TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	521.7	3.07
347	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	307.4	4.04
348	Brick TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	201.7	4.74
349	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1165.5	3.57
350	Brick TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	580.7	5.12
351	Brick TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	259.3	4.54
401	Brick TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	574.3	3.73
402	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	976.6	4.52
403	Brick TWP	Sand bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	442.7	4.62
404	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	537.5	4.76

405	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	587.2	3.32
406	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1320.3	3.56
407	Brick TWP	Vegetated or sandy bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1727.7	4.13
408	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	593.2	4.03
409	Brick TWP	Coniferous forest	Constructing new levee / dike	86.7	4.42
410	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	555.3	3.26
411	Brick TWP	Coniferous forest	Constructing new levee / dike	1645.6	2.92
412	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2238.5	4.12
413	Brick TWP	Coniferous forest	Constructing new levee / dike	2092.0	3.63
414	Brick TWP	Coniferous forest	Constructing new levee / dike	897.9	1.70
415	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	969.6	4.19
416	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	991.6	3.71
417	Brick TWP	Vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	606.3	5.30
418	Brick TWP	Roadway edge	Constructing new levee / dike	762.8	4.82
419	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	480.8	3.59
420	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	821.1	3.28
421	Brick TWP	Salt marsh	Constructing new levee / dike	863.7	4.85
422	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1398.8	3.54
423	Brick TWP	Salt marsh	Constructing new levee / dike	751.7	4.49
424	Brick TWP	Shrub wetland	Constructing new levee / dike	1021.9	4.63
425	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2646.3	4.44
426	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1524.4	3.81
427	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1351.5	3.65
428	Brick TWP	Salt marsh	Constructing new levee / dike	501.1	3.53

429	Brick TWP	Salt marsh	Constructing new levee / dike	967.5	4.32
430	Brick TWP	Dock / shipyard	Constructing movable or removable flood panel	1070.6	4.62
431	Brick TWP	Roadway edge	Constructing new levee / dike	766.0	4.71
432	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	703.6	4.91
433	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1329.2	4.98
434	Brick TWP	sand beach bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	737.8	5.75
435	Brick TWP	Bridge	Constructing movable or removable flood panel	193.8	1.73
436	Brick TWP	Bridge	Constructing movable or removable flood panel	205.8	1.67
437	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1014.4	4.91
438	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead t with or without movable panel Constructing new concrete flood wall with or without movable panel	247.0	5.05
439	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2856.3	4.16
440	Brick TWP	Bridge	Constructing movable or removable flood panel	135.1	1.03
441	Brick TWP	Bridge	Constructing movable or removable flood panel	117.5	1.03
442	Brick TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	902.1	5.60
443	Brick TWP	Midstreams Rd edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	277.3	1.90
444	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	421.6	5.57
449	Brick TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1353.1	4.32
468	Brick TWP	Wooded wetlands	Constructing new levee / dike Raising the residences (3 units)	758.6	2.09

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
325	Eagleswood TWP	Upland rights-of-way undeveloped	Constructing new levee / dike over upland	4220.2	5.08

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
214	Island Heights Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2118.2	2.97
215	Island Heights Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1191.5	3.57
216	Island Heights Boro.	Dock/shipyard	Constructing movable or removable flood panel	463.3	3.35
217	Island Heights Boro.	Dock/shipyard	Constructing movable or removable flood panel	510.5	5.00
218	Island Heights Boro.	Dock/shipyard	Constructing movable or removable flood panel	521.5	4.65
219	Island Heights Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3930.2	4.39
382	Island Heights Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	465.3	4.78

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
247	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	582.7	5.05
248	Lavallette Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3828.6	3.23
249	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6026.3	3.03
363	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1285.8	4.18
364	Lavallette Boro.	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	617.1	4.63

365	Lavallette Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	227.3	4.74

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
300	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	9942.1	6.02
301	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	4506.8	7.86
302	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	16050.3	7.72
303	Little Egg Harbor TWP	Salt marsh	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1555.3	6.99
304	Little Egg Harbor TWP	Salt marsh	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1988.1	6.77
305	Little Egg Harbor TWP	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1017.1	6.84
306	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike alone roadway	2562.3	6.34
307	Little Egg Harbor TWP	Shrub wetland	Constructing new levee / dike	2998.1	3.56
312	Little Egg Harbor TWP	Wooded wetland	Constructing new levee / dike	681.2	2.79
313	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	2650.8	7.38
314	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	5460.7	6.90
459	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	3985.4	7.34
460	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	2479.8	7.35
461	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	1640.2	7.53
462	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	924.8	7.40
463	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	1167.0	7.67
464	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	2176.6	7.64
465	Little Egg Harbor TWP	Salt marsh	Constructing new levee / dike	1070.4	7.66

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
11	Mantoloking Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6092.8	4.97

12	Mantoloking Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6579.2	3.87
482	Mantoloking Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6041.4	4.15

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
23	Pt. Pleasant Beach Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6978.5	2.82
24	Pt. Pleasant Beach Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2622.7	4.52
328	Pt. Pleasant Beach Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	792.7	5.53

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
1	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1541.9	4.46
3	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	6211.6	4.81
4	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	837.9	3.85
5	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1917.7	4.59
6	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2769.5	4.43
7	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1625.3	4.08
8	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1115.8	4.64
25	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1083.1	4.69
26	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2891.4	3.97
27	Pt. Pleasant Boro.	Salt marsh	Constructing new levee / dike	610.6	6.47
29	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	913.0	5.12
30	Pt. Pleasant Boro.	Dock / shipyard bank	Constructing new metal sheet bulkhead with or without movable panel	502.7	5.52

			Constructing new concrete flood wall with or without movable panel		
31	Pt. Pleasant Boro.	Salt marsh	Constructing new levee / dike	772.2	6.18
32	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	115.0	4.76
33	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	282.5	3.99
34	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	408.2	4.84
35	Pt. Pleasant Boro.	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel	109.2	6.01
36	Pt. Pleasant Boro.	Wooded wetland	Constructing new levee / dike	2595.6	4.49
37	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1274.6	4.69
38	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5177.9	3.51
135	Pt. Pleasant Boro.	Bridge	Constructing movable or removable flood panel	1041.4	0.97
136	Pt. Pleasant Boro.	Bridge	Constructing movable or removable flood panel	768.2	0.86
329	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1898.9	3.54
330	Pt. Pleasant Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	460.2	4.76
331	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2146.1	2.85
332	Pt. Pleasant Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1157.8	4.77
333	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	249.3	6.11
334	Pt. Pleasant Boro.	Roadway edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1542.5	3.09
335	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	411.3	5.68
336	Pt. Pleasant Boro.	Salt marsh	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	285.4	5.63
338	Pt. Pleasant Boro.	Mixed wooded wetland	Constructing new levee / dike Constructing new concrete flood wall with or without movable panel	770.2	2.78
339	Pt. Pleasant Boro.	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	355.4	5.38

340	Pt. Pleasant Boro.	Route 88 edge	Constructing new concrete flood wall with or without movable panel	840.4	2.42
445	Pt. Pleasant Boro.	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without removable panel	837.5	4.51
446	Pt. Pleasant Boro.	Bridge	Constructing movable or removable flood panel	122.9	1.28
447	Pt. Pleasant Boro.	Bridge	Constructing movable or removable flood panel	128.8	1.44
448	Pt. Pleasant Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	523.7	5.27
478	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	514.5	4.92
479	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	199.5	4.19
481	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2682.3	2.25
28	Pt. Pleasant Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	802.2	4.59

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
255	Seaside Heights Boro.	Beach earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2749.1	2.50
368	Seaside Heights Boro.	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1258.1	4.77
474	Seaside Heights Boro.	Sand dune (Ocean side)	Constructing new concrete flood wall (Seawall) with or without movable panel Constructing new dune with or without rubble or tube core New dune with layer cemented by spraying sand color cement liquid below top sand layer	4182.9	9.19

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
258	Seaside Park Boro.	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1691.7	3.85
259	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1237.5	4.29
260	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1567.2	5.28
261	Seaside Park Boro.	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	3833.7	4.31
370	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1937.0	4.49
371	Seaside Park Boro.	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	309.4	4.91
372	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2864.4	3.59
373	Seaside Park Boro.	Dock inland side	Constructing Concrete flood wall with or without removable panel	2683.5	3.62
374	Seaside Park Boro.	Bay bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1180.8	5.09
375	Seaside Park Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	489.2	4.79
477	Seaside Park Boro.	Sand dune (Ocean side)	Constructing new concrete flood wall (Seawall) with or without movable panel Constructing new dune with or without rubble or tube core New dune with layer cemented by spraying sand color cement liquid below top sand layer	2107.7	9.24

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
231	South Toms River Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2424.4	2.25

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
264	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4420.6	2.02
265	Stafford TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1540.2	2.39
266	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	8137.3	2.02
267	Stafford TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	241.5	5.77
268	Stafford TWP	Newell Ave edge	Constructing new levee / dike along roadway Raising roadway Newell Ave	8471.3	4.72
269	Stafford TWP	Herbaceous wetland	Constructing new levee / dike	445.0	2.89
270	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	421.6	2.29
271	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	750.5	2.40
272	Stafford TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	499.5	5.21
273	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	803.5	3.60
274	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1148.8	4.07
275	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	879.0	3.71
276	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	602.9	2.14
277	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	659.0	6.51
278	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	738.4	4.22
279	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1864.6	4.86
280	Stafford TWP	Coastal wetland	Constructing new levee / dike	699.1	4.80
281	Stafford TWP	Coastal wetland	Constructing new levee / dike	548.8	4.70
282	Stafford TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	902.6	5.15

283	Stafford TWP	E Bay Ave edge	Constructing new levee / dike Raising the roadway	4769.2	6.21
284	Stafford TWP	Hillard Blvd edge	Constructing new levee / dike along the roadway Raising roadway	1352.6	1.77
285	Stafford TWP	Hillard Blvd edge	Constructing new levee / dike along roadway Raising roadway	716.3	5.17
286	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1446.8	4.98
287	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1115.8	3.88
288	Stafford TWP	Salt marsh	Constructing new levee / dike	859.8	5.23
289	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	847.5	4.18
290	Stafford TWP	Bridge	Constructing movable or removable flood panel	446.2	0.80
291	Stafford TWP	Bridge	Constructing movable or removable flood panel	440.5	1.43
292	Stafford TWP	Bridge	Constructing movable or removable flood panel	324.8	2.25
293	Stafford TWP	Bridge	Constructing movable or removable flood panel	341.1	1.28
294	Stafford TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel Constructing new concrete flood wall with or without movable panel	698.6	2.91
295	Stafford TWP	Salt marsh	Constructing new levee / dike	714.6	5.02
296	Stafford TWP	Bridge	Constructing movable or removable flood panel	455.1	2.94
297	Stafford TWP	Bridge	Constructing movable or removable flood panel	458.9	1.04
298	Stafford TWP	Bridge	Constructing movable or removable flood panel	2417.9	1.68
299	Stafford TWP	Bridge	Constructing movable or removable flood panel	2418.3	0.48
326	Stafford TWP	Roadway edge	Constructing new levee / dike Raising roadway	902.1	4.13
327	Stafford TWP	Roadway edge	Constructing new levee / dike Raising roadway	71.7	2.51
450	Stafford TWP	Sand beach bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	767.7	3.93
451	Stafford TWP	Recreation land	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	239.4	3.53

452	Stafford TWP	Salt marsh	Constructing new levee / dike	475.7	5.44
453	Stafford TWP	E Bay Ave edge	Constructing new concrete flood wall with or without removable panel Constructing new concrete flood wall with or without movable panel	299.8	3.10
454	Stafford TWP	Salt marsh bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1294.8	5.49

OBJECTID	**Mun. Name**	**Existing Condition**	**Selected Flood Defense Measures**	**Length**	**Ave. Water Depth**
22	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2418.3	3.42
352	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	253.8	5.28
353	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	136.8	5.35
125	Toms River TWP	Roadway edge	Constructing concrete flood wall with or without removable panel	174.5	1.62
148	Toms River TWP	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2215.5	4.33
149	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel Adding concrete flood wall with or without movable panel	140.3	5.21
150	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	463.9	4.79
151	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel Adding concrete flood wall with or without movable panel	232.5	4.77
152	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2551.7	4.17
153	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	349.5	5.89
154	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	2487.7	4.41

155	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4981.4	3.61
156	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1372.5	4.18
157	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	383.1	3.65
158	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	241.3	3.99
159	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	319.0	4.39
160	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	228.5	4.14
161	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1271.6	4.11
162	Toms River TWP	Salt marsh bank	Constructing new levee / dike	768.0	6.76
163	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	353.1	4.05
164	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1363.2	3.54
165	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3743.5	3.10
166	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	968.7	3.37
167	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1269.4	3.99
168	Toms River TWP	Sand / vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	263.0	4.94
169	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2657.8	4.21
170	Toms River TWP	Sand / vegetated bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	196.4	5.47
171	Toms River TWP	Salt marsh	Constructing new levee / dike	213.3	6.38
172	Toms River TWP	Salt marsh	Constructing new levee / dike	570.4	5.83
173	Toms River TWP	Sand/earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	273.2	5.56
174	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	864.2	3.98
175	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2554.1	3.63
176	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	701.4	3.62

177	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	821.1	3.91
178	Toms River TWP	Wooded wetland	Constructing new levee / dike	817.7	4.15
179	Toms River TWP	Wooded wetland	Constructing new levee / dike	252.0	4.67
180	Toms River TWP	Wooded wetland	Constructing new levee / dike	3342.8	5.18
181	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2696.0	4.40
182	Toms River TWP	Wooded wetland	Constructing new levee / dike	222.0	5.74
183	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	779.9	4.64
184	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	593.2	4.27
185	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1787.8	3.84
186	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1131.2	4.01
187	Toms River TWP	Wooded wetland	Constructing new levee / dike	1466.3	3.67
188	Toms River TWP	Wooded wetland	Constructing new levee / dike	3448.6	3.71
189	Toms River TWP	Wooded wetland	Constructing new levee / dike	2848.5	2.19
190	Toms River TWP	Wooded wetland	Constructing new levee / dike	5323.6	3.04
191	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1768.9	4.21
192	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel	301.8	5.51
			Constructing new concrete flood wall with or without movable panel		
193	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	86.5	4.58
194	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	563.2	3.63
195	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	307.9	3.85
196	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	825.5	3.69
197	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	549.5	3.68
198	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	432.5	3.64
199	Toms River TWP	Vegetated earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	91.4	5.45
200	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	718.3	5.30

201	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3029.8	4.17
202	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	643.7	4.78
203	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	235.3	6.03
204	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	4409.5	2.78
205	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	559.5	4.00
206	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1235.3	3.26
207	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	278.1	3.61
208	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	672.2	3.34
209	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	123.9	4.26
210	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	663.8	4.85
211	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2394.4	4.02
212	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	406.5	4.77
213	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1892.8	3.31
220	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2000.3	2.87
221	Toms River TWP	Wooded wetland	Constructing new levee / dike	622.6	2.69
222	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3128.1	4.36
223	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1341.6	3.16
224	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1370.5	5.27
225	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2228.2	3.96
226	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1210.6	2.90
227	Toms River TWP	Dock / shipyard	Constructing concrete flood wall with or without removal panel	841.7	3.49

			Constructing movable or removable flood panel		
228	Toms River TWP	E Water St edge	Constructing new concrete flood wall with or without removable panel	117.0	2.51
229	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	943.8	4.40
230	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	174.7	5.14
232	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	236.9	5.90
233	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	304.9	4.25
234	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1083.3	4.22
235	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2280.1	3.16
236	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	491.8	4.27
237	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	614.7	4.06
238	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1836.5	4.06
239	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	2893.2	3.91
240	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1178.1	4.87
241	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	227.8	5.04
242	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	127.9	5.64
243	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1877.7	3.42
244	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	378.3	5.22
245	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	584.6	4.63
246	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	363.2	3.19
250	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1486.6	3.94
251	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	3918.5	3.78
252	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	950.0	4.13

253	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	378.4	4.44
254	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	611.4	4.52
256	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1001.1	4.17
317	Toms River TWP	Bridge over water	Constructing movable or removable flood panel	4876.3	1.31
318	Toms River TWP	Bridge over water	Constructing movable or removable flood panel	4878.6	1.66
320	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	889.1	4.55
322	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	322.2	3.30
354	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	867.2	4.01
355	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	240.7	5.15
356	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	200.3	3.09
357	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	90.7	4.36
358	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	412.3	4.29
359	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	232.6	4.68
360	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	221.5	3.23
361	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	272.2	4.32
362	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	268.1	4.74
366	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	422.7	3.49
367	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	676.9	4.04
377	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	876.4	3.83

378	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	503.8	3.64
379	Toms River TWP	Route 37 edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1384.5	1.70
380	Toms River TWP	Route 37 edge	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1201.1	2.35
381	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1719.9	3.65
383	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1276.6	4.20
384	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	201.1	3.50
385	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	485.3	4.30
386	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	460.1	4.13
387	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	858.4	4.09
388	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	488.7	3.49
389	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	344.8	5.01
390	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	269.9	4.66
391	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	149.7	4.91
392	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	173.0	4.41
393	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	539.5	4.81
394	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	378.2	4.26
395	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel	652.0	4.60

			Constructing new concrete flood wall with or without movable panel		
396	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	5738.2	3.63
397	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	222.6	4.94
398	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	802.8	4.47
399	Toms River TWP	Sand / earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	568.4	4.46
400	Toms River TWP	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1349.0	4.33

OBJECTID	Mun. Name	Existing Condition	Selected Flood Defense Measures	Length	Ave. Water Depth
308	Tuckerton Boro.	Salt marsh	Constructing new levee / dike	1701.6	4.32
309	Tuckerton Boro.	Deciduous / shrubland	Constructing new levee / dike	646.0	3.82
310	Tuckerton Boro.	Salt march	Constructing new levee / dike	11368.8	6.10
311	Tuckerton Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1156.0	4.47
315	Tuckerton Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1182.9	5.61
316	Tuckerton Boro.	Salt marsh	Constructing new levee / dike	1516.4	6.08
319	Tuckerton Boro.	Wooded wetland	Constructing new levee / dike	2551.0	1.98
455	Tuckerton Boro.	Salt marsh	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without movable panel	1039.8	6.16
456	Tuckerton Boro.	Sand / earth bank	Constructing new metal sheet bulkhead height with or without movable panel Constructing new concrete flood wall with or without removable panel	864.6	5.20
457	Tuckerton Boro.	Bulkhead	Increasing bulkhead height by adding concrete flood wall with or without movable panel	1103.0	5.07
458	Tuckerton Boro.	Earth bank	Constructing new metal sheet bulkhead with or without movable panel Constructing new concrete flood wall with or without removable panel	475.9	6.06

E4 List of Proposed Sluice Gate/In-Water Barrier/Flood Gate/Culvert/Flap Gate

ID No.	Mun. Name	BarrierGate_Type	Length
1	Point Pleasant Beach Borough	Sluice Gate or In-Water Mobile Barrier	259.0
2	Point Pleasant Borough	Flood Gate	60.7
3	Point Pleasant Borough	Flood Gate	70.8
4	Point Pleasant Borough	Sluice Gate or In-Water Mobile Barrier	53.6
5	Point Pleasant Borough	Sluice Gate or In-Water Mobile Barrier	68.7
7	Point Pleasant borough	Sluice Gate or In-Water Mobile Barrier	67.9
9	Bay Head Borough	Sluice Gate or In-Water Mobile Barrier	103.6
10	Point Pleasant Borough	Sluice Gate or In-Water Mobile Barrier	116.6
11	Point Pleasant Borough	Sluice Gate or In-Water Mobile Barrier	79.6
12	Point Pleasant Borough	Sluice Gate or In-Water Mobile Barrier	135.0
13	Point Pleasant Borough	Sluice Gate or In-Water Mobile Barrier	187.4
14	Point Pleasant Borough	Sluice Gate or In-Water Mobile Barrier	159.5
17	Point Pleasant Borough	Sluice Gate or In-Water Mobile Barrier	83.4
18	Point Pleasant Borough	Sluice Gate or In-Water Mobile Barrier	88.7
19	Point Pleasant Borough	Sluice Gate or In-Water Mobile Barrier	82.0
20	Point Pleasant Borough	Sluice Gate or In-Water Mobile Barrier	118.6
21	Point Pleasant Borough	Sluice Gate or In-Water Mobile Barrier	55.5

ID No.	Mun. Name	BarrierGate_Type	Length
22	Boundary of Pt. Pleasant Boro and Brick TWP	Flap Gate	27.1
25	Brick Township	Flap Gate	30.7
26	Brick Township	Flap Gate	37.1
27	Brick Township	Sluice Gate or In-Water Mobile Barrier	113.3
28	Brick Township	Sluice Gate or In-Water Mobile Barrier	123.3
29	Brick Township	Sluice Gate or In-Water Mobile Barrier	95.2
30	Brick Township	Sluice Gate or In-Water Mobile Barrier	144.1
31	Brick Township	Sluice Gate or In-Water Mobile Barrier	89.0
32	Brick Township	Flap Gate	60.3
33	Brick Township	Flap Gate	61.9
34	Brick Township	Sluice Gate or In-Water Mobile Barrier	177.5
35	Brick Township	Sluice Gate or In-Water Mobile Barrier	36.7
36	Brick Township	Sluice Gate or In-Water Mobile Barrier	51.1
37	Brick Township	Sluice Gate or In-Water Mobile Barrier	94.2
38	Brick Township	Sluice Gate or In-Water Mobile Barrier	76.2
39	Brick Township	Sluice Gate or In-Water Mobile Barrier	111.1
40	Brick Township	Flood Gate	95.0
41	Mantoloking Borough	Flood Gate	59.7
42	Brick Township	Sluice Gate or In-Water Mobile Barrier	119.3
43	Brick Township	Sluice Gate or In-Water Mobile Barrier	283.5
44	Brick Township	Sluice Gate or In-Water Mobile Barrier	222.1

45	Brick Township	Sluice Gate or In-Water Mobile Barrier	75.0
46	Brick Township	Sluice Gate or In-Water Mobile Barrier	59.6
47	Brick Township	Sluice Gate or In-Water Mobile Barrier	102.1
48	Brick Township	Sluice Gate or In-Water Mobile Barrier	60.3
49	Brick Township	Sluice Gate or In-Water Mobile Barrier	168.1
50	Brick Township	Sluice Gate or In-Water Mobile Barrier	122.5
51	Brick Township	Sluice Gate or In-Water Mobile Barrier	87.7
52	Brick Township	Sluice Gate or In-Water Mobile Barrier	88.4
53	Brick Township	Sluice Gate or In-Water Mobile Barrier	98.0
54	Brick Township	Sluice Gate or In-Water Mobile Barrier	33.0
55	Brick Township	Sluice Gate or In-Water Mobile Barrier	53.7
56	Brick Township	Sluice Gate or In-Water Mobile Barrier	106.7
57	Brick Township	Sluice Gate or In-Water Mobile Barrier	74.2
58	Brick Township	Flap Gate	46.1
59	Brick Township	Flap Gate	61.6
60	Brick Township	Sluice Gate or In-Water Mobile Barrier	91.2
61	Brick Township	Sluice Gate or In-Water Mobile Barrier	93.2
62	Brick Township	Sluice Gate or In-Water Mobile Barrier	87.8
63	Brick Township	Sluice Gate or In-Water Mobile Barrier	85.1
64	Boundary of Brick TWP and Toms River TWP	Sluice Gate or In-Water Mobile Barrier	42.0

ID No.	Mun. Name	BarrierGate_Type	Length
66	Toms River Township	Sluice Gate or In-Water Mobile Barrier	125.2
67	Toms River Township	Sluice Gate or In-Water Mobile Barrier	114.2
68	Toms River Township	Sluice Gate or In-Water Mobile Barrier	149.0
69	Toms River Township	Sluice Gate or In-Water Mobile Barrier	73.9
70	Toms River Township	Sluice Gate or In-Water Mobile Barrier	60.3
71	Toms River Township	Sluice Gate or In-Water Mobile Barrier	101.0
72	Toms River Township	Sluice Gate or In-Water Mobile Barrier	85.7
73	Toms River Township	Sluice Gate or In-Water Mobile Barrier	117.9
74	Toms River Township	Sluice Gate or In-Water Mobile Barrier	135.4
75	Toms River Township	Sluice Gate or In-Water Mobile Brier	77.3
76	Toms River Township	Sluice Gate or In-Water Mobile Barrier	111.4
77	Toms River Township	Sluice Gate or In-Water Mobile Barrier	75.5
78	Toms River Township	Sluice Gate or Culvert with Flap Gate	56.2
79	Toms River Township	Sluice Gate	86.8
80	Toms River Township	Sluice Gate or In-Water Mobile Barrier	93.6
81	Toms River Township	Sluice Gate or In-Water Mobile Barrier	69.6
82	Toms River Township	Sluice Gate or Culvert with Flap Gate	42.4
83	Toms River Township	Flap Gate	81.4
84	Toms River Township	Sluice Gate or In-Water Mobile Barrier	81.1

85	Toms River Township	Sluice Gate or In-Water Mobile Barrier	101.0
86	Toms River Township	Sluice Gate or In-Water Mobile Barrier	92.7
87	Toms River Township	Sluice Gate or In-Water Mobile Barrier	86.4
88	Toms River Township	Sluice Gate or In-Water Mobile Barrier	73.1
89	Toms River Township	Sluice Gate or In-Water Mobile Barrier	87.9
90	Toms River Township	Sluice Gate or In-Water Mobile Barrier	144.1
91	Toms River Township	Sluice Gate or In-Water Mobile Barrier	157.8
92	Toms River Township	Sluice Gate or In-Water Mobile Barrier	138.4
93	Toms River Township	Sluice Gate or In-Water Mobile Barrier	116.8
94	Toms River Township	Sluice Gate or In-Water Mobile Barrier	100.5
95	Toms River Township	Sluice Gate or In-Water Mobile Barrier	108.0
96	Toms River Township	Sluice Gate or In-Water Mobile Barrier	90.4
97	Toms River Township	Sluice Gate or In-Water Mobile Barrier	90.2
98	Boundary of Toms River TWP and Island Height Boro	Sluice Gate or In-Water Mobile Barrier	80.9
99	Toms River Township	Sluice Gate or In-Water Mobile Barrier	48.6
100	Toms River Township	Sluice Gate or In-Water Mobile Barrier	89.3
101	Toms River Township	Sluice Gate or In-Water Mobile Barrier	64.5
102	Toms River Township	Sluice Gate or In-Water Mobile Barrier	48.9
103	Toms River Township	Sluice Gate	80.2
104	Boundary of Toms River TWP and S. Toms River Boro	Sluice Gate	50.0

105	Toms River Township	Sluice Gate or In-Water Mobile Barrier	73.2
107	Toms River Township	Sluice Gate or In-Water Mobile Barrier	65.7
108	Toms River Township	Sluice Gate or In-Water Mobile Barrier	121.7
109	Toms River Township	Sluice Gate or In-Water Mobile Barrier	93.9
110	Toms River Township	Sluice Gate or In-Water Mobile Barrier	89.9
111	Toms River Township	Sluice Gate or In-Water Mobile Barrier	265.9
112	Toms River Township	Sluice Gate or In-Water Mobile Barrier	226.5
113	Toms River Township	Sluice Gate or In-Water Mobile Barrier	93.6
114	Toms River Township	Sluice Gate or In-Water Mobile Barrier	38.5
115	Toms River Township	Sluice Gate or In-Water Mobile Barrier	36.0
116	Toms River Township	Sluice Gate or In-Water Mobile Barrier	38.4
117	Toms River Township	Sluice Gate or In-Water Mobile Barrier	73.2
118	Toms River Township	Sluice Gate or In-Water Mobile Barrier	42.2
119	Toms River Township	Sluice Gate or In-Water Mobile Barrier	98.8
120	Toms River Township	Sluice Gate or In-Water Mobile Barrier	90.0
121	Lavallette Borough	Sluice Gate or In-Water Mobile Barrier	104.6
122	Lavallette Borough	Sluice Gate or In-Water Mobile Barrier	62.5
123	Boundary of Toms River TWP and Lavallette Boro	Sluice Gate or In-Water Mobile Barrier	98.9
124	Toms River Township	Sluice Gate	39.2
125	Toms River Township	Sluice Gate or In-Water Mobile Barrier	144.4

126	Toms River Township	Sluice Gate or In-Water Mobile Barrier	71.6
127	Toms River Township	Sluice Gate or In-Water Mobile Barrier	102.3
128	Toms River Township	Sluice Gate or In-Water Mobile Barrier	92.8
129	Seaside Heights Borough	Sluice Gate	125.1
130	Seaside Heights Borough	Sluice Gate	119.1
131	Seaside Park Borough	Sluice Gate or In-Water Mobile Barrier	87.4
170	Toms River Township	Flood Gate	94.7
173	Toms River Township	Flood Gate	96.9

ID #	Mun. Name	BarrierGate_Type	Length
135	Stafford Township	Flood Gate	38.7
136	Stafford Township	Culvert with Flap Gate	33.3
137	Stafford Township	Sluice Gate	43.2
138	Stafford Township	Sluice Gate	84.7
139	Stafford Township	Flood Gate	63.0
140	Stafford Township	Sluice Gate or In-Water Mobile Barrier	163.6
141	Stafford Township	Sluice Gate or In-Water Mobile Barrier	149.1
142	Stafford Township	Sluice Gate or In-Water Mobile Barrier	177.3
143	Stafford Township	Sluice Gate or In-Water Mobile Barrier	151.3
144	Stafford Township	Sluice Gate or In-Water Mobile Barrier	63.3
174	Stafford Township	Flood gate	64.9
175	Stafford Township	Flood gate	67.8

ID #	Mun. Name	BarrierGate_Type	Length
145	Little Egg Harbor Township	Culvert with Flap Gate or Sluice Gate	85.9
146	Tuckerton Borough	Culvert with Flap Gate or Sluice Gate	105.4
147	Tuckerton Borough	Culvert with Flap Gate	13.7
148	Tuckerton Borough	Sluice Gate or In-Water Mobile Barrier	114.1
149	Tuckerton Borough	Sluice Gate or In-Water Mobile Barrier	173.6
150	Boundary of Tuckerton and Little Egg Harbor TWP	Sluice Gate or In-Water Mobile Barrier	309.5
151	Little Egg Harbor Township	Sluice Gate or In-Water Mobile Barrier	97.6
152	Little Egg Harbor Township	Culvert with Flap Gate	97.5
153	Little Egg Harbor Township	Culvert with Flap Gate	44.6
154	Little Egg Harbor Township	Culvert with Flap Gate or Sluice Gate	250.4
155	Little Egg Harbor Township	Culvert with Flap Gate	15.8
156	Little Egg Harbor Township	Sluice Gate or In-Water Mobile Barrier	152.1
157	Little Egg Harbor Township	Sluice Gate or In-Water Mobile barrier	186.5
158	Little Egg Harbor Township	Culvert with Flap Gate	38.8
159	Little Egg Harbor Township	Culvert with Flap Gate	10.4
160	Little Egg Harbor Township	Culvert with Flap Gate	15.3
161	Little Egg Harbor Township	Culvert with Flap Gate	12.2
162	Little Egg Harbor Township	Culvert with Flap Gate	15.9
163	Little Egg Harbor Township	Culvert with Flap Gate	30.1
164	Little Egg Harbor Township	Culvert with Flap Gate	77.6
165	Little Egg Harbor Township	Culvert with Flap Gate	120.8
166	Little Egg Harbor Township	Culvert with Flap Gate	35.5
167	Little Egg Harbor Township	Culvert with Flap Gate	10.4

168	Little Egg Harbor Township	Culvert with Flap Gate	31.3
169	Little Egg Harbor Township	Culvert with Flap Gate	12.8

Appendix F Stormwater Green Infrastructure Methodology

Green Infrastructure Deployment: Introduction and Methodology

By Qizhong Guo, Kaveh Gharyeh, and Manoj Raavi

1) Green Infrastructure

Green Infrastructure or Blue-green infrastructure is a network providing the "ingredients" for solving urban and climatic challenges by building with nature. The main components of this approach include storm water management, climate adaptation, less heat stress, more biodiversity, food production, better air quality, sustainable energy production, clean water and healthy soils, as well as the more anthropocentric functions such as increased quality of life through recreation and providing shade and shelter in and around towns and cities. Figure 1 shows several green infrastructures that are commonly implemented in different locations.

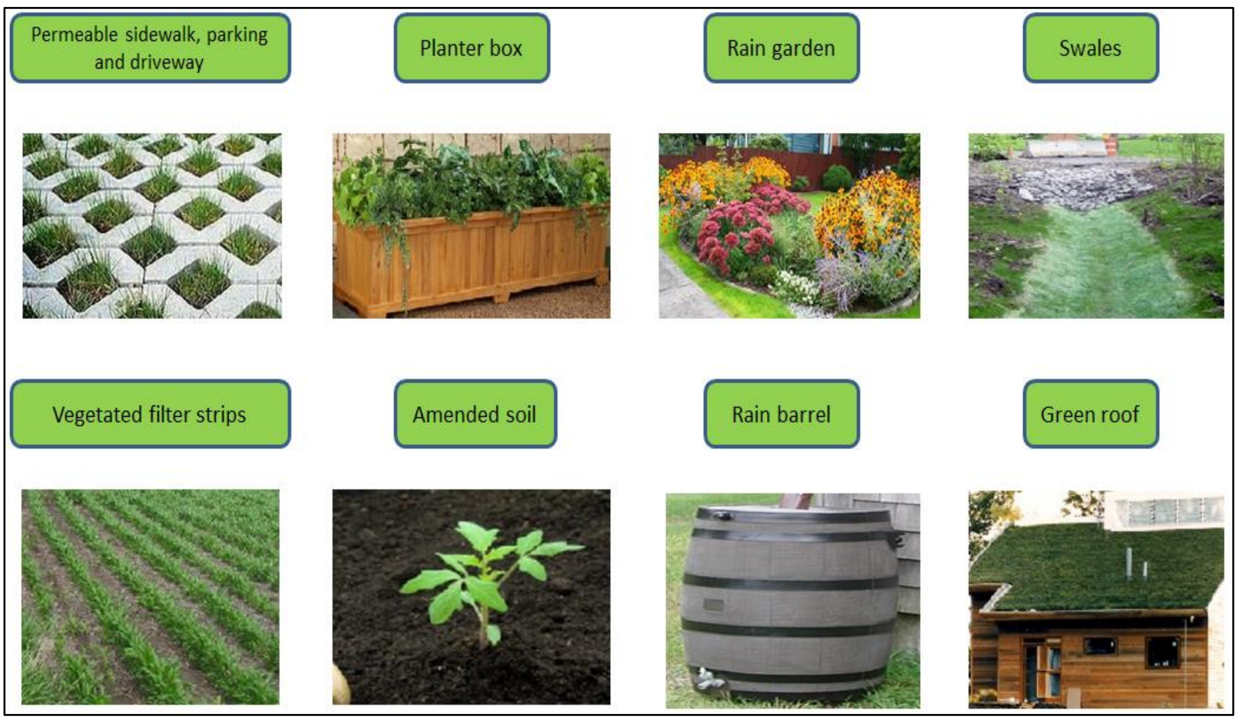

Figure 1 : Green Infrastructure types

US Department of Environmental Protection (DEP) is conducting a comprehensive research to quantify non-stormwater benefits of green infrastructure deployment [2]. For instance, City of Hoboken, New Jersey, is conducting a green infrastructure strategic plan to develop place–based stormwater management and flood control strategies and identify implementable climate adaptation action steps. More details of the Hoboken Green Infrastructure Strategic plan is available on [3]. There are other ongoing green infrastructure projects in a number of cities all around the U.S such as Philadelphia, New York City, San Francisco, Chicago, Seattle and St. Louis. More details of these projects are available on [4], [5], [6], [7], [8] and [9] respectively.

Green infrastructure can reduce the volume of water going into combined systems during precipitation events by removing surface runoff, which may reduce number and volume of overflows. Green infrastructure can also slow the delivery of wet weather flows to sewer systems, helping to mitigate peak flows while providing filtration through soil for some portion of the release into the sewer system, thereby reducing pollutant loads. The implementation of green infrastructure practices may allow communities to downsize certain grey infrastructure components of their CSO control plans. This may provide some CSO communities with significant cost savings [10]. By implementing Green Infrastructure, need for piping, pumping and storage of stormwater could be reduced. In this project, the main reason to consider green infrastructures deployment is also to reduce the stormwater inflow to the drainage system by removing fraction of runoff. Table 1 summarizes the problem, our approach and source of floodwater.

[2] NYC Environmental Protection website:
http://www.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_pilot_monitoring_results.shtml
[3] http://togethernorthjersey.com/?grid-portfolio=hoboken-green-infrastructure-strategic-plan
[4] http://www.phillywatersheds.org/whats_in_it_for_you/businesses/green-infrastructure-projects
[5] http://www.nyc.gov/html/dep/html/stormwater/green_infrastructure_slideshow.shtml
[6] http://sfwater.org/index.aspx?page=614
[7] http://www.seattle.gov/util/MyServices/DrainageSewer/Projects/GreenStormwaterInfrastructure/index.htm
[8] http://www.stlmsd.com/educationoutreach/msdgreeninitiatives
[9] http://www.epa.state.il.us/water/financial-assistance/igig.html
[10] http://water.epa.gov/infrastructure/greeninfrastructure/upload/EPA-Green-Infrastructure-Factsheet-2-061212-PJ.pdf

Table 1: Problem and solution description

Problem to solve	Reduce surface floodwater inlet to the drainage system
Approach	Removal of runoff by using optimal combinations of green infrastructures
Source of floodwater	Rainfall only (1 year and 2 year return periods)

2) Software developed

Online software is developed to calculate the total cost (capital, maintenance and replacement) of implementing the green infrastructures. Unlike available online softwares, the developed software is capable of fining out the most cost effective combination of different green infrastructures that can be implemented in any location. Spatial limitations for implementing any of the green infrastructure types are taken into consideration. Net Present Value (NPV) approach is used to calculate the total cost of implementing green infrastructure. Total cost includes the initial capital cost, maintenance cost and also replacement cost. Figure 2 shows a snap shot of a page of the developed software.

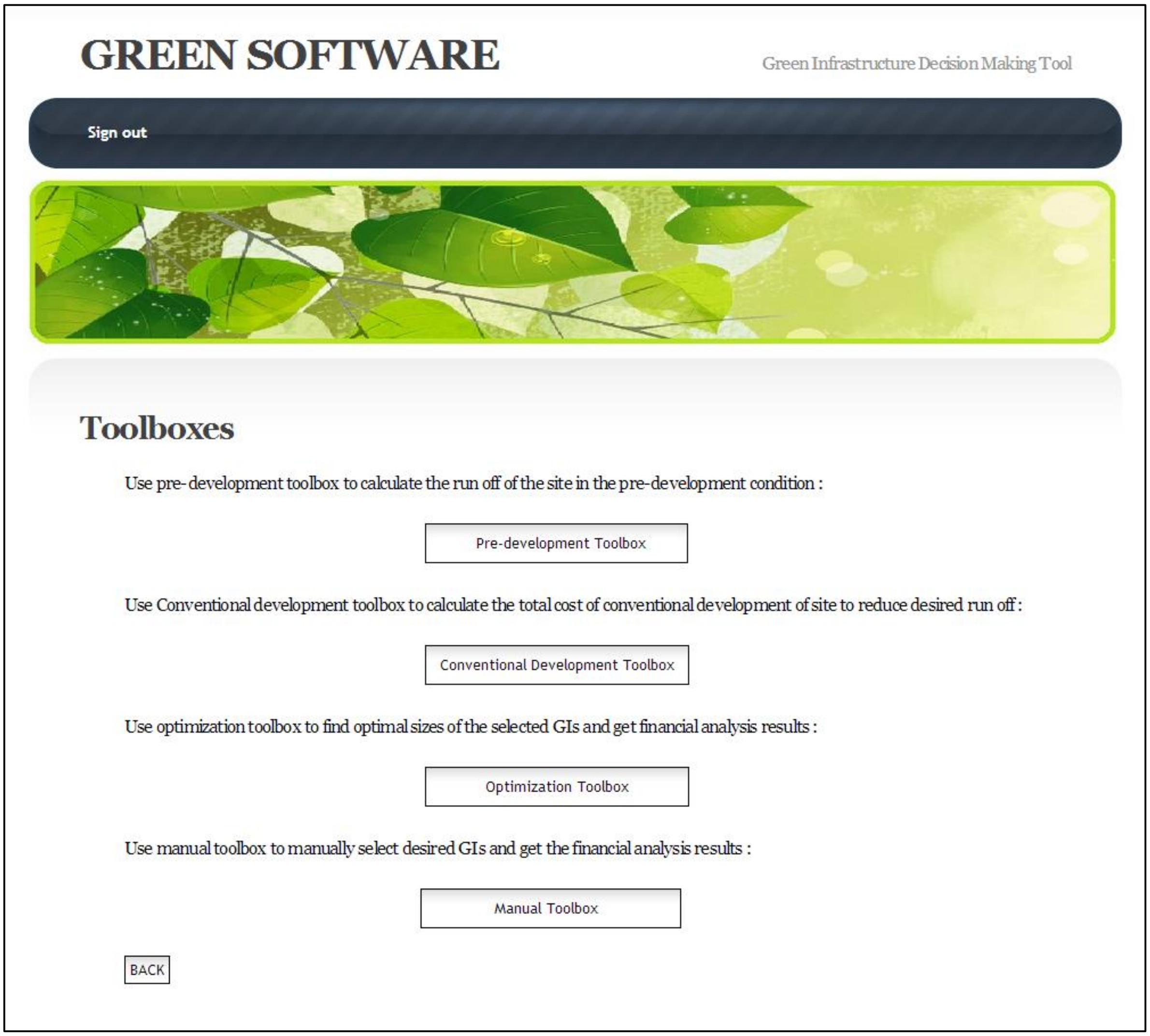

Figure 2 : Snapshot of the Green Software

The software interface is developed in JAVA, however the inside optimization engine is coded in MATLAB and then converted to JAVA packages.

3) Different sites spatial characteristics and limitations

In order to find out the total area of each site under research, GIS data is used. In addition the maximum area for implementing each of the green infrastructure types is found out via the following procedure for residential, industrial and commercial units.

3.1) Procedure

Step 1: Selection of Municipality

From the New Jersey state map of municipalities, select the municipalities required and make a layer from the selected municipality. Figure 2, shows a sample layer.

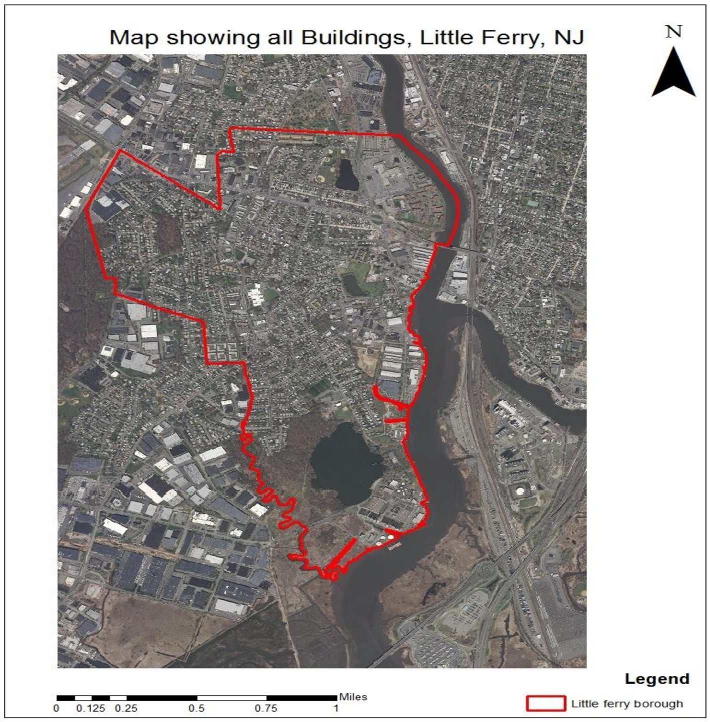

Figure 3 : Sample layer of a municipality

Step 2: Finding out maximum area to implement green roofs, permeable driveway and parking

For each type of residential units (i.e. low, medium and high density), three unique polygons are chosen. For each polygon the area of roof, parking and driveway are extracted. The average ratio of roofs, parking and driveway is multiplied to the total area of residential area of the municipality to find out the approximate total areas of roofs, parking and driveways. The same procedure repeats for the industrial and commercial sectors. For example, in order to find out the total area of roof, parking and driveway of the high density or multiple dwelling residential units in Hoboken, New Jersey, three sample polygons of high density residential units are selected. Table 2 shows the extracted information of the aforementioned polygons.

Table 2 : Extracted information for three selected polygons

	Total Area(ft^2)	**Roof(ft^2)**	**Parking(ft^2)**	**Driveway(ft^2)**
Polygon 1	216372	68388	18448	19041
Polygon 2	91164	29973	11780	9383
Polygon 3	119191	47149	14733	12434

Table 3 represents the ratio of roof, parking and driveway area to the total area for each polygon.

Table 3: Ratio of roof, parking and driveway in each polygon

	Percentage of roof area in polygon	**Percentage of parking area in polygon**	**Percentage of driveway area in polygon**
Polygon 1	31.6	8.5	8.8
Polygon 2	32.9	12.9	10.3
Polygon 3	39.5	12.3	10.4
Average	34.6	11.2	9.8

By using the average ratios and multiplying in the total high density residential units' area, the total area of roof, parking and driveway of this class of residential units are calculated as shown in Table 4.

Table 4: Hoboken high density residential units estimated roof, parking and driveway area

Roof(ft^2)	Parking(ft^2)	Driveway(ft^2)	Total area of high density residential units (ft^2)
6221824	2014001	1762250	17982151

Exactly the same procedure is carried out for industrial and commercial sectors of the municipality and the results are summed up to come up with the maximum spatial limitation to deploy each of the green infrastructures.

Step 3: Finding out maximum area to implement permeable roadway and sidewalk

By getting the map of NJ road networks and clipping it for the area of the required municipality, we can find the total length of the road network. From this we can find the length of the road where sidewalks is present. By multiplying the width of the side walk we can find the area of the pavement where we can apply permeable sidewalk.

The average width of the side walk for the major highway is calculated from the widths measured at several selected locations (by using the GIS measure tool). The average width was found to be 6ft on each side of the roadway. Considering the intersections of roadways, roadways with sidewalk on only one side and roadways without a sidewalk on both sides, only 50% of the total length of roadways in the town is used to calculate the area of sidewalk.

Step4: Finding out maximum area to implement rain gardens, swales, vegetated filter strips and planter box

For calculating the area of the site where rain gardens can be installed, we have assumed that the area of rain gardens will be 5% of the roof area. For calculating the area where vegetative swales and vegetative filter strips can be installed, we assumed a percentage of 80% of the length of sidewalk will be accessible for installing swales and remaining 20% will be used to install vegetated filter strip. For planter box implementation, we need to assume a percentage of area of the total roof area to find the area where the planter boxes can be installed. We assumed it to be 1% of total roof area.

4) Default values used in the software

In order to carry out the cost and the optimal combination calculations, the porosity and depth of each of green infrastructures are set to default values as shown in Table 5. However, values other than default values can simply be entered as inputs to the developed software.

Table 5: Default values for porosity and depth of green infrastructures

Permeable sidewalk depth (in)	12
Permeable sidewalk porosity	0.35
Permeable parking depth (in)	12
Permeable parking porosity	0.35
Permeable driveway depth (in)	12
Permeable driveway porosity	0.35
Bioswales depth (in)	12
Bioswales porosity	0.35

Green roof depth (in)	12
Green roof porosity	0.35
Planter box prepared soil depth (in)	12
Planter box aggregate soil depth (in)	12
Planter box prepared soil porosity	0.35
Planter box aggregate soil porosity	0.35
Rain garden prepared soil depth (in)	12
Rain garden aggregate soil depth (in)	12
Rain garden prepared soil porosity	0.35
Rain garden aggregate soil porosity	0.35
Vegetated filter strips depth (in)	12
Vegetated filter strips porosity	0.35

Unit capital and maintenance costs along with life time of each type of green infrastructure are also presented in table 6. Long lifetime of green infrastructure types is considered.

Table 6: Unit capital and maintenance costs and life time of each green infrastructure type

Green Infrastructure type	Capital cost ($/ft^2)	Yearly maintenance cost ($/ft^2)	Life time (Years)
Permeable sidewalk, driveway and parking (Asphalt)	6.65	0.17	50
Permeable sidewalk, driveway and parking (Cement)	7.70	0.16	50
Permeable sidewalk, driveway and parking (Gravel)	4.01	0.02	50
Bioswale	14.80	0.13	50
Planter Box	11	0.61	50
Rain Garden	9.4	0.41	50
Green Roof	18.76	0.15	50
Vegetated Filter Strip	1.6	0.07	50

Reference: [[11]]

As a part of analysis, green infrastructure cost is compared to the cost of gray infrastructure implementation to remove the same amount of runoff. The gray infrastructure cost includes onsite underground retention/detention system [[12]] cost, and required cost of standard roof, pavement, driveway and parking lot. In our methodology, we do not take into consideration the replacement cost of standard roof, pavement, driveway and parking lot to green infrastructure. In other words,

[11] http://greenvalues.cnt.org/national/cost_detail.php
[12] http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_runoff.pdf

we assume that we conduct a new development. Table 7 provides detailed information applied for gray infrastructure cost calculation.

Also note that some existing green infrastructure measures such as amended soil, rain barrels, and vertical walls are not included in the software. The software can be expanded to include these existing measures as well as the future emerging measures.

Table 7: Detailed data required for Gray Infrastructure cost calculation

Infrastructure type	Capital cost	Yearly maintenance cost ($\$/ft^2$)	Life time (Years)
Concrete Sidewalk	5.19 ($\$/ft^2$)	0.029	80
Concrete Driveway	5.19 ($\$/ft^2$)	0.029	80
Parking Lot	5.51 ($\$/ft^2$)	0.15	30
Standard Roof	7.5 ($\$/ft^2$)	0.05	30
onsite underground retention/detention system	11.55 ($\$/ft^3$)	0.03	30

Appendix G Unit Cost Tables

Unit Cost Tables

Table 1 Unit Costs for Storm Surge Barrier

Measures	Unit & Unit	Reference
Levee	Clay levee: 4000 to 8000 $/linear foot	http://www.stronglevees.com/cost/
	T-walls: 14000 to 19000 $/linear foot	http://www.stronglevees.com/cost/
	Double wall levee: 5000 to 6000 $/linear foot	http://www.stronglevees.com/cost/
Levee raise	1) Levee raise with a floodwall (unit cost per linear foot) 1-foot raise: $37 1-to 3-foot raise: $120 Greater than 3-foot raise: $875 2) Levee raise by fill (unit cost per linear foot) 1-foot raise: $31 1-to 3-foot raise: $45 Greater than 3-foot raise: $87	http://www.papiopartnership.org/projects/damsite_15a_2_221441182.pdf
Sea Wall	300 $/linear foot	Contacted Jeff Patterson
	300 to 400$ per foot for walls 7' in height	Contacted Gary Kalke
Beach Nourishment	6.67 $ /cy @ 2011 @ Florida	Page 6 of : http://fsbpa.com/2012TechPresentations/AlBrowder.pdf
Bulkhead	3000 $/lf	Contacted : Tom Levy
Elevate Buildings	@New Jersey $ 60 per square feet	http://www.markofexcellence.com/house-lifting.html
Wetland Restoration	Very wide range, $900-$90,000/acre	http://www.edc.uri.edu/restoration/html/tech_sci/socio/costs.htm
Flood wall sheet pile	@2014 : 25 $/sf	http://www.icgov.org/site/CMSv2/Auto/construction/bid338/212201431318.pdf
Road elevation	~ 1.6 M$ per mile per foot elevation	http://marylandreporter.com/2013/08/01/rising-seas-5-800-miles-of-roads-at-risk-especially-in-shore-counties/
Removable Flood Wall	100$ per square feet	Contacted : Mr. Bryan Fryklund @ Flood Control America (FCA)

Table 2 Unit Costs for Mobile Flood Barrier

Measures	Cost & Unit	Reference
Muscle Wall	-2’ Muscle Wall 50 $/LF excludes tax, installation, liner, sandbags, Muscle Wall accessories -4’ Muscle Wall 99 $/LF excludes tax, installation, liner, sandbags, Muscle Wall accessories -8’ Muscle Wall 525 $/LF excludes tax, installation, liner, sandbags, Muscle Wall accessories	Contacted Organic Industries Flood, LLC
Slide gate (12X6 ft^2)	@ 2014: 47,000 $ EA	http://www.icgov.org/site/CMSv2/Auto/construction/bid338/212201431318.pdf
Flood barrier (In water closure)	$880 x length (ft) x height (ft) x design head difference (ft)	Reconnaissance Level Study Mississippi Storm Surge Barrier, by Van Ledden et al. (2011)
Sand bag	Average cost of a pre-filled 50 lbs sandbag = $2.25	http://barriersystemsllc.com/make-money.php

Table 3 Unit Costs for Diversion

Measures	Unit & Unit	Reference
Sewer	PVC Sewer Pipe, 8 Inch Diameter: Unit: LF cost: $300 10/12 inch can be installed with a box, use $300-$350 per foot	Bid Tabulation for Horseshoe Bend Levee Improvements Project (Phase II) – Bidder : SCI Infrastructure, LLC

Table 4 Unit Costs for Tide Barrier

Measures	Cost & Unit	References
Flap gates	Diameter: 2 ft : $3,000 Diameter: 3 ft : $4,500 Diameter: 6 ft :$15,000	Contacted: hydro power company : http://www.hydrogate.com/sales-reps.aspx?S=NJ
	72" X 72" FLAP gate @ 2008 : 35,000 $	http://www.rcgov.org/pdfs/Public-Works/1736%20Levee%20Storm%20Sewer%20Flap%20Gates.pdf
	@2012 @CITY OF KENT : Flap Gate for 24 Inch Pipe 1 EA 5,200 Flap Gate for 8 Inch Pipe 1 EA 2,500 Flap Gate for 12 Inch Pipe 1 EA 3, 000 Flap Gate for 48 Inch Pipe 1 EA 9, 000	Bid Tabulation for Horseshoe Bend Levee Improvements Project (Phase II) – Bidder : SCI Infrastructure, LLC
	@ 2013 @ Kansas: Flap gate: 24" cost: 2500 EA Flap gate: 30" cost: 3000 EA	http://www.hutchgov.com/egov/docs/13831420807713.pdf
Sluice gate	Sluice gates, cast iron Hydraulic structures, 18" x 18", HD, self cont with crank, sluice Detail $ 7,764.89 / EA Hydraulic structures, 24" x 24", HD, self cont with crank, sluice Detail $ 10,011.41 / EA Hydraulic structures, 30" x 30", HD, self cont with crank, sluice Detail $ 11,828.56 / EA Hydraulic structures, 36" x 36", HD, self cont with crank, sluice Detail $ 13,627.37 / EA Hydraulic structures, 42" x 42", HD, self cont with crank, sluice Detail $ 16,221.16 / EA Hydraulic structures, 48" x 48", HD, self cont with crank, sluice Detail $ 19,026.87 / EA Hydraulic structures, 54" x 54", HD, self cont with crank, sluice Detail $ 26,137.59 / EA Hydraulic structures, 60" x 60", HD, self cont with crank, sluice Detail $ 31,611.97 / EA Hydraulic structures, 66" x 66", HD, self cont with crank, sluice Detail $ 36,680.48 / EA	http://www.allcostdata.info/browse.html/059110009

	Hydraulic structures, 72" x 72", HD, self cont with crank, sluice Detail $ 43,605.95 / EA Hydraulic structures, 78" x 78", HD, self cont with crank, sluice Detail $ 48,429.74 / EA Hydraulic structures, 84" x 84", HD, self cont with crank, sluice Detail $ 64,999.97 / EA Hydraulic structures, 90" x 90", HD, self cont with crank, sluice Detail $ 60,630.76 / EA Hydraulic structures, 96" x 96", HD, self cont with crank, sluice Detail $ 67,440.10 / EA Hydraulic structures, 108" x 108", HD, self cont with crank, Detail $ 87,380.36 / EA Hydraulic structures, 120" x 120", HD, self cont with crank, Detail $ 117,696.03 / EA Hydraulic structures, 132" x 132", HD, self cont with crank, Detail $ 168,117.06 / EA	

Table 5 Unit Costs for Pumping Station

Measures	Cost & Unit	References
Pump station	For stormwater, $C = 149055\ Q^{0.6907}$, where C = cost ($), Q = pump flow rate (cfs)	C-111 Spreader Canal Western Project Final Project Implementation Report (PIR) and Environmental Impact Statement (EIS) Final - January 2011: Appendix B - Cost Estimates http://www.evergladesplan.org/pm/projects/docs_29_c111_pir.aspx
	For wastewater, $ 750,000 at 0 – 0.99 MGD, $ 2M at 1.00 – 4.99 MGD, $ 5M at 5.00 – 9.99 MGD, $12.5M at 10.00 – 24.99 MGD, $ 22.5M at 25.00 – 49.00 MGD, $ 35M at 50.00 – 74.00 MGD, and $ 50M at 75.00 or larger MGD.	New Hampshire Department of Environmental Services - Water Division http://des.nh.gov/organization/divisions/water/wweb/documents/ar_appendix_g.pdf

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Table 6 Unit Costs for Conveyance

Measures	Cost & Unit		References
Culvert			
Size	material	Price	
12” x 10”	Steel	104	https://shop.mccoys.com/farm-ranch-yard/culverts/steel-culverts-and-accessories/steel-culverts
12” x 12”	Steel	124	
12” x 20”	Steel	199	
12” x 24”	Steel	246	
15” x 10”	Steel	155	
15” x 16”	Steel	204	
15” x 20”	Steel	289	
15” x 30”	Steel	385	
18” x 16”	Steel	249	
18” x 20”	Steel	335	
18” x 24”	Steel	369	
18” x 30”	Steel	469	
24” x 20”	Steel	395	
24” x 24”	Steel	475	
24” x 30”	Steel	599	
30” x 30”	Steel	749	
36” x 30”	Steel	949	
Dredging	Cost to design and build the spoil area, and dredge the material: $4.00 to $8.00 per cubic yard. Combined charge for mobilization and de-mobilization: $20,000 to $50,000. For preliminary cost estimates, use the average of the above costs.		http://www.dredgingspecialists.com/Dredging101.htm
	Hydraulic: 5-15 $/CY and Mechanical: 8-30 $/cy		http://www.epa.state.il.us/water/conservation/lake-notes/lake-dredging.pdf
Sewer	PVC Sewer Pipe, 8 Inch Diameter: Unit: LF cost: 300.00 $ 10/12 inch can be installed with a box, use $300-$350 per foot		Bid Tabulation for Horseshoe Bend Levee Improvements Project (Phase II) – Bidder : SCI Infrastructure, LLC

Table 7 Unit Costs for Rainfall Interception

Measures	Cost & Unit	Reference
Green Roof	15.75 ($ /sq ft)	http://greenvalues.cnt.org/national/cost_detail.php
Permeable pavement/ driveway/ parking (Material :Asphalt)	6.34 ($ /sq ft)	http://greenvalues.cnt.org/national/cost_detail.php
Permeable pavement/ driveway/ parking (Material :Asphalt)	6 ($ /sq ft)	http://greenvalues.cnt.org/national/cost_detail.php
Permeable pavement/ driveway/ parking (Material : Gravel)	4.32 ($ /sq ft)	http://greenvalues.cnt.org/national/cost_detail.php
Swales	15 ($ /sq ft)	http://greenvalues.cnt.org/national/cost_detail.php
Vegetated Filter Strips	1.45 ($ /sq ft)	http://greenvalues.cnt.org/national/cost_detail.php
Planter Box	8 ($ /sq ft)	http://greenvalues.cnt.org/national/cost_detail.php
Rain Garden	7 ($ /sq ft)	http://greenvalues.cnt.org/national/cost_detail.php
Amended Soil	30 ($ / CY)	http://greenvalues.cnt.org/national/cost_detail.php

Table 8 Unit Costs for Storage

Measures	Cost & Unit	Reference
Excavation	35 ($ / CY)	http://www.state.nj.us/transportation/business/procurement/ConstrServ/documents/BidTabs13454.pdf